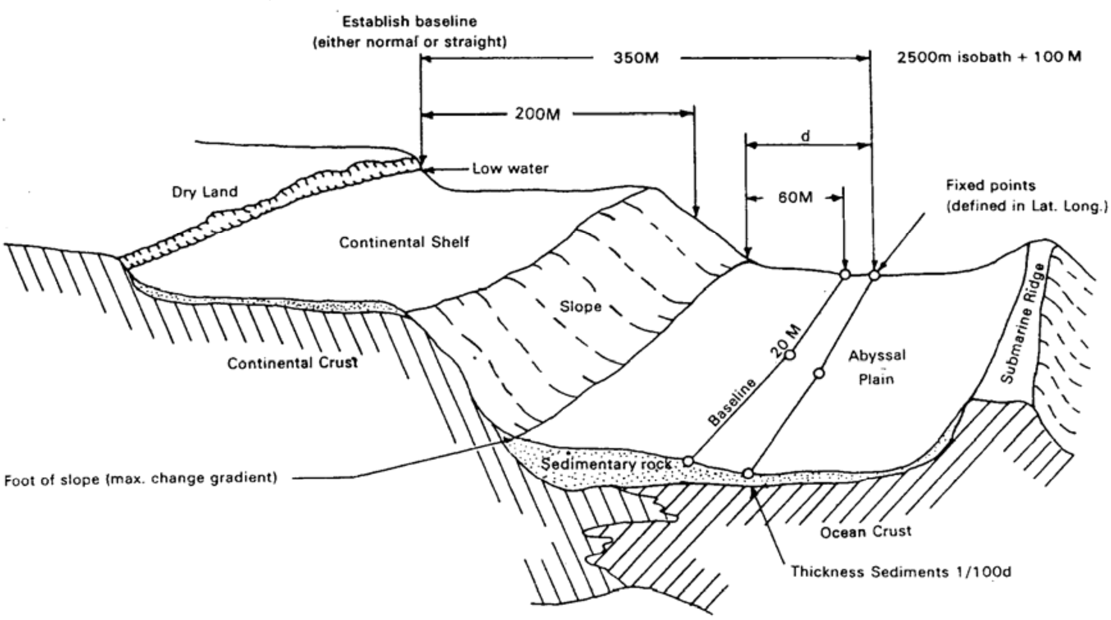
INTERNATIONAL
OCEANOGRAPHIC
COMMISSION

INTERNATIONAL
HYDROGRAPHIC
ORGANIZATION

INTERNATIONAL
ASSOCIATION OF
GEODESY

A MANUAL ON TECHNICAL ASPECTS OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA - 1982

[Prepared by the IHO, IAG, IOC Advisory Board on Law of the Sea (ABLOS)]



Special Publication No. 51
4th Edition - March 2006
Published by the
International Hydrographic Bureau
MONACO

TABLE OF CONTENTS

List of Figures

Page N°

Chapter 2 Geodesy

Chapter 3 Nautical Charts

List of Tables

PREFACE

The United Nations Convention on the Law of the Sea (UNCLOS) was signed at Montego Bay, Jamaica, on 10 December 1982. The signing of the Convention marked the conclusion of the Third United Nations Conference on Law of the Sea which had lasted from 1973-1982. The Convention entered into force on 16 November 1994, twelve months after the sixtieth instrument of ratification or accession had been deposited with the United Nations.

It is not necessary to dwell on the accomplishments of the Conference or the future impact of the Convention on mankind. It is sufficient to note that the Convention combines in one treaty the four conventions that were signed at Geneva in 1958, dealing with the Law of the Sea, namely: The Territorial Sea and the Contiguous Zone; the High Seas; Fishing and Conservation of the Living Resources of the High Seas; and the Continental Shelf. In addition, within its 320 articles and 9 annexes, the 1982 Convention covers many new areas of concern, including in particular the protection and preservation of the environment and the resources of the deep ocean floor.

Aspects of the Convention that are of particular concern to hydrographers include those articles dealing with delimitation of maritime boundaries, the conduct and promotion of marine scientific research and the development and transfer of marine technology. It was clear that the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) would have a part to play in some of the technical aspects of implementing the Convention. Accordingly in July 1983 a meeting was arranged between Ambassador Bernardo ZULETA, Mr. Jean-Pierre LEVY (UN), Rear Admiral Frank FRASER (President IHB)[1], Vice Admiral O.A.A. AFFONSO (Director, IHB), Dr. Mario RUIVO (Secretary IOC) and Mr. Desmond SCOTT (Secretary GEBCO). As outlined in IHB Circular Letter 28/1983, the IHO was invited to provide technical advice and information on baselines and geodetic datums.

In order to fulfil its obligations the President of the IHB initiated the concept of a Working Group to develop an IHO Special Publication on the Technical Aspects of the Law of the Sea Convention. Participation in this group was invited in IHB Circular Letter 37/1984 and Circular Letter 16/1985 announced the twelve members of the group. The TALOS (Technical Aspects of the Law of the Sea) Working Group was duly constituted. (See Appendix 4 for the Group's membership).

At the Working Group’s first meeting in Monaco, 2-4 October 1985, the late Rear Admiral FRASER agreed to assume the Chairmanship. There was general consensus that the manual should have the following structure:

(a) Introduction - explaining the scope of the manual.
(b) List of hydrographic terms and concepts related to the Law of the Sea including illustrations of a general nature.
(c) Possible practical applications - field work, charting work and computations. Appendix of computer programmes.
(d) Annotated bibliography - this section would not have an IHO endorsement and would simply list available published literature, work done in different countries, etc.

[1] IHB - International Hydrographic Bureau - the Secretariat of the International Hydrographic Organization (IHO).

During 1986 work proceeded on (b) which became Part I - the GLOSSARY and the Appendix to (c) which became Appendix 2 - Computer Programmes. The latter was completed under the supervision of Japan. Work commenced on (c) which became Part II - Practical_Applications. France and Italy undertook initial work on this section and the IHB Consultants provided editorial and general assistance for both Part I and II.

Three further meetings were held in Monaco. At the second meeting, 1-3 April 1987, the first draft of the Glossary was reviewed. At the third meeting, 27-29 April 1988, the Glossary was completed, a major revision of Part II undertaken and a decision taken that Part III - Computer Programs should be slightly expanded and become an appendix. At the fourth meeting, 22-24 May 1989, Part II - Practical Applications was reviewed.

During 1989 the International Association of Geodesy (IAG) formed a Special Study Group on the Geodetic Aspects of the Law of the Sea. In view of the special expertise within this group it was invited to join the TALOS Working Group at its fifth meeting, held in Monaco from 16-18 May 1990. It was decided, whenever applicable, to make reference throughout the text, to a report on geodetic applications which would be produced by the IAG Special Study Group. This report would provide the reader of this Manual with greater detail on the application of geodetic methods. Consequently it was decided to omit the Appendix on the Calculation of Angles and Distances on the Ellipsoid from this text. Additionally in view of the need for consistency with the newly published Fourth Edition of the Hydrographic Dictionary (S-32) it was decided to amend Part I - the GLOSSARY, which had been published separately in 1988.

For the third edition it was decided to omit Appendix 2 - Computer Programmes due to the rapid obsolescence of such information.

In late 2002, the joint IHO / IAG / IOC Advisory Board on Hydrographic, Geodetic and Marine Geo-Scientific Aspects of the Law of the Sea (ABLOS), whose Terms of Reference now included the review and updating of the TALOS Manual, decided to set up an editorial group to prepare a 4th Edition. The Editorial Group first met at the IHB on 23rd and 24th October 2003 prior to the 3rd ABLOS Conference where it elected Ron Macnab of Canada as its chairman. A second meeting was held at the IHB on 29th and 30th March 2004 and further meetings were held in conjunction with the annual business meetings of ABLOS in October 2004 and October 2005.

It was agreed that the 4th Edition would primarily be a digital publication and would be aimed at a non-specialist audience. It was decided to incorporate the additional material on “The Nautical Chart” in Appendix 1 to the 3rd Edition, into the main chapter. It was further decided to incorporate material from the “Geodetic Commentary to the TALOS Manual”, largely prepared by P. Vaníček, and published by the IHO as a separate Appendix in 1996, into the Manual. The Chapter dealing with the “Outer Limits” would now include a review of the nomenclature used in “Article 76”.

THROUGHOUT THE TEXT THE ARTICLES REFERRED TO ARE THOSE OF THE LOS CONVENTION.

CHAPTER 1 - INTRODUCTION

TABLE OF CONTENTS

1. INTRODUCTION

UNCLOS is a complex and broad-ranging formulation of international law that seeks to regulate the use of the world's oceans for the benefit of mankind. Numerous scientific and technical considerations impinge upon the application of UNCLOS, just as UNCLOS has implications for the practice of marine science and technology. This Manual addresses the interplay between the Law of the Sea and the disciplines of Geodesy, Hydrography, and Geoscience. It provides an overview of a series of technical issues whose satisfactory realization is key to the orderly practice of international law in the ocean environment.

The present Chapter contains a general introduction to the Law of the Sea, and to the technical and scientific activities that will be discussed at length in the remainder of the Manual.

1.1 A SHORT HISTORY OF THE LAW OF THE SEA AND UNCLOS

1.1.1 Prior to 1982

The first known line drawn in the seas of the world was declared in 1493 by the Bull *Inter Caetera* by Pope Alexander VI. He declared that the islands and mainlands to the west of a meridian of longitude 100 leagues west of the Azores and Cape Verde, through Brazil were to be considered Spanish and those to the east of this meridian to be Portuguese, provided no Christian king was in actual possession of the territory.

This meridian was adjusted in 1494 by the Treaty of Tordesillas between Spain and Portugal westwards to a line 370 leagues to the west of the Cape Verde Islands. The "Eastern Sea" was divided between Spain and Portugal by the Treaty of Zaragoza of 1529. Again a meridian of longitude was used running through the centre of Australia with the lands to the east being Spanish and to the west Portuguese.

In the United Kingdom James I of England declared the "King's Chambers" in 1604. This Proclamation enclosed seas around England and Wales joining some 27 headlands with straight lines and declared that the water thus enclosed were under the sovereignty of the King. Diagrams of these claims can be found in "Lines in the Sea" edited by Francalanci and Scovazzi.

In contrast to early claims to control the seas, in the early seventeenth century the right of the freedom of the seas was contained within a treatise by Grotius entitled *Mare Liberum*. This work purported to prove that there was a right to trade freely and was published as a direct challenge to the Portuguese claim to the "Eastern Seas".

So already by the seventeenth century there were two camps – coastal State control and freedom of the seas - that remain to this day. However it was accepted by both camps that coastal States did have a right to control waters close to their land territory, by force if necessary. The "cannon shot" rule, as it became known therefore grew to mean control of inshore waters by the use of cannon on headlands and other promontories. This in turn developed into a general recognition that one marine league around the coast was under the control of the State that owned the coast.

Following the First World War, the international community recognised that a codification of international maritime law, as it applied to the generation of coastal State maritime space, was needed. Accordingly, the League of Nations sponsored a conference in The Hague in 1930 to discuss the codification of the law relating to coastal State controls within the territorial sea, and to freedoms of the high seas. No Treaty was produced from this conference, largely because of the politically sensitive issue of fisheries, but it was agreed that the conference should be reconvened at a later date.

Following the Second World War and the establishment of the United Nations, an early task was to look again at the question of the codification of international maritime law. The International Law Commission was charged with the formulation of draft articles for a treaty or treaties on the law of the sea. The Commission began its work in 1950, submitting its results to the General Assembly in 1956.

In the meantime, the first maritime boundary to be delimited beyond the territorial sea was created between Venezuela and the United Kingdom on behalf of Trinidad and Tobago in 1942. This established a right to the continental shelf, provided it was occupied. In 1945 the Truman Proclamation on the continental shelf asserted that a State had a right to its continental shelf as an extension to its landmass out to 100 fathoms. Other developments in law of the sea matters included an important International Court of Justice (ICJ) case in 1951, between the United Kingdom and Norway concerning the use of straight baselines from which to calculate the territorial sea. The Court found in favour of Norway, thus declaring that this type of baseline was legal in that particular geographical circumstance.

Thus followed the First Geneva Conference of the Law of the Sea in 1958. What emerged were four Conventions rather than one, which was not originally intended. However it was the first time that the Law of the Sea had been codified. It can also be said that several parts of these Conventions were considered progressive and were intended to be enhanced by custom with advances in ocean development. The four Conventions were: The Convention on the Territorial Sea and the Contiguous Zone; The Convention on the High Seas; The Convention on Fishing and Conservation of the Living Resources of the High seas; and the Convention on the Continental Shelf. Each Convention had to be ratified separately and the take-up was not universal.

The Convention on the Territorial Sea and the Contiguous Zone was ratified by 45 States, but it failed to agree on the width of these zones. This lead to the requirement to hold a second Law of the Sea Conference to try and resolve this issue. This was convened in Geneva in 1960, but again the width question was not agreed. An agreement for a 6 nautical mile (M) territorial sea and a further 6M for the contiguous zone failed in plenary by one vote.

The Convention on the High Seas was largely a success and was ratified by 56 States. Much of its content remains in force today and is reflected in the present Law of the sea Convention. The Convention on Fishing and Conservation of the Living Resources of the High Seas was not a success. Only 35 States have ratified this Convention.

The Continental Shelf Convention on the other hand has been very successful with 53 States ratifying. It enabled States to explore and exploit the non living resources of their sea beds from the early 1960s with confidence. Moreover, it proved significant that the wording of the

Convention stated that the continental shelf was the sea bed and subsoil adjacent to the coast out to 200 metres or as far as it could be exploited. It was thus effectively open-ended.

During the 1960s and 1970s several law of the sea issues developed. The unilateral extension of territorial sea claims, some out to 200M, caused concern to those States trying to maintain freedom of the high seas, while others claimed that these extensions maintained their rights over resources. Fishery zones had progressively extended from 12M in the 1950s to 200M by the middle of the 1970s. This was in part due to the three “cod wars” between the United Kingdom and Iceland between 1958 and 1976. There were also several court cases regarding delimitation during this period, including the ICJ North Sea Continental Shelf case of 1969 between Germany, The Netherlands, and Denmark and the Western Channel arbitration between the United Kingdom and France in 1977.

Perhaps the most significant development during this period was the discovery of manganese nodule fields in the deep ocean basins of the World. It was feared that this supposedly vast mineral wealth would be exploited by the major industrialised nations for their own benefit. In an attempt to curtail this, Ambassador Pardo of Malta submitted a resolution at the General Assembly of the United Nations in 1967, introducing the concept that the resources of the deep ocean should be exploited for the benefit of all mankind. This sowed the seed for the beginning of the process leading up to the Third United Nations Conference on the Law of the Sea.

A Seabed committee was constituted by the General Assembly to look into this matter, and it soon became apparent that it would be necessary to consider the existing Geneva Conventions in their entirety. The Third United Nations Conference on the Law of the Sea began this task in Caracas in 1974. This activity culminated in the drafting of the United Nations Convention on the Law of the Sea (UNCLOS), which was opened for signature on 10 December 1982.

The work of the Conference was divided among three main committees. The first committee was required to draft the articles concerning the deep sea bed provisions, including the mechanisms for their implementation. The second committee covered the more traditional maritime zones and navigation provisions, with the introduction of two new concepts: the exclusive economic zone, and the archipelagic State provisions. The third committee covered the complex areas of marine scientific research and the protection and preservation of the marine environment, as well as the other miscellaneous provisions. This was all put into various negotiating texts by the fourth committee.

The successful outcome of this conference, lasting some eleven sessions over a period of some eight years, is considered by many to be one of the most significant achievements by the United Nations to date.

1.1.2 After 1982

The 1982 Convention (UNCLOS) required 60 States to deposit articles of ratification or accession with the Secretary General of the United Nations to bring it into force one year after the date of the sixtieth ratification. It became clear that by the early 1990s the sixtieth ratification was close, but that most States which had ratified up to that time were developing Nations.

The reason for this was a perceived problem with the provisions for the deep seabed within the Convention. When these articles were drafted and approved, the major industries in the World economy were largely State owned and run. This changed during the late 1970s and 1980s to privately run international companies with very different requirements. The deep seabed provisions in Part XI of the Convention simply would not work as they were drafted. The dilemma facing the international community, and the Secretary General in particular, was how to change those provisions without altering the Convention. A Convention can be neither accepted nor applied in selective fashion, so if Part XI were to be re-drafted in the traditional sense, then the whole of the Convention would have been liable to revision. This would have endangered the carefully negotiated package between State jurisdiction and freedom of navigation issues, which was not acceptable to the international community.

To resolve this problem, the Secretary General launched a series of meetings between the industrialised nations and those nations that had already ratified the Convention. Time was short: the sixtieth ratification was deposited on 16th November 1993 and it was considered that an agreement was vital before the Convention came into force for those States that had ratified. An ingenious and innovative solution was achieved in the early summer of 1993, and a special sitting of the General Assembly was organised to debate and agree on the solution. This was achieved and the implementing Agreement Relating to Part XI of the UN Convention on the Law of the Sea was opened for signature on 28 July 1994.

This enabled the vast majority of the industrialised nations to sign and ratify the Convention. To date (December 2005) some 149 States have ratified or acceded - a remarkable achievement.

1.2 COMPOSITION OF THE CONVENTION AND RELATED AGREEMENTS

The Convention comprises 320 Articles divided into 17 Parts, with nine Annexes. The Agreement relating to Implementation of Part XI of the Convention consists of 10 Articles and nine annexed Sections.

The Agreement relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks came into force on December 11, 2001. It contains 50 Articles in thirteen parts, with two Annexes.

Details concerning the contents and the status of the Convention and the related Agreements are available on the website of the UN Division of Ocean Affairs and the Law of the Sea (DOALOS): http://www.un.org/Depts/los/index.htm

1.3 TECHNICAL ASPECTS OF UNCLOS

This Section defines the broad objectives of the disciplines of Geodesy, Hydrography, and Geoscience, and outlines their relevance to UNCLOS.

1.3.1 Geodesy

The old Greeks developed theoretical and applied geometry, later called geodesy (from Greek: $\gamma\eta$ = *earth*, $\delta\alpha\iota\omega$ = I divide), as a branch of astronomy to determine the size and shape of the earth. Today geodesy is the science related with positioning, gravity field mapping and geodynamics in broad senses. The various parts of geodesy can be studied in the global, regional and local scales, each part of which calls for its specific theory and methodology. In the local scale geodesy is frequently denoted plane surveying. Geodesy can also be divided into geodetic (natural) science, which is part of the earth sciences, and geodetic engineering. Geodetic science includes subjects as gravimetry, physical geodesy, ellipsoidal geodesy, global and regional geodetic networks, while geodetic engineering includes land surveying, topographic mapping, hydrographic surveying, mining surveying, geomatics, etc. Historically, the global aspects dominated geodetic science, while geodetic engineering was related with regional and local tasks and methods. However, the advent of satellite geodesy, such as GPS, has more or less erased the boundaries between global and local methods in geodesy. This implies a trend towards the use of global reference systems in the vertical and horizontal as well as rigorous observation and computational methods in local applications. For instance, the International Association of Geodesy urge all geodetic users to use the Geodetic Reference System 1967, and the International Reference Frame, including a global network of precisely determined fixed points, is recommended for the establishment of local control networks. Although this trend may seem to make theory more complicated for the practically minded user, in the long run the implementation of UNCLOS will benefit from the rigour of theory and practical results.

1.3.2 Hydrography

Hydrography is defined by the IHO as: *That branch of applied sciences which deals with the measurement and description of the features of the seas and coastal areas for the primary purpose of navigation and all other marine purposes and activities, including inter alia: offshore activities, research, protection of the environment and prediction services.*

Hydrography therefore deals with all those operations necessary to determine the configuration of the ocean / sea floor. In addition to measuring the depth of the seafloor it will include a wide variety of other measurements for instance: tides, currents, gravity, magnetic field strength and the physical, chemical and structural properties of the water column and the seabed.

The process of hydrographic surveying may be summarised as:

a. The collection by systematic surveys at sea and along the coast of geo-referenced data relating to:

   - Coastal morphology, including man made infrastructure, for maritime navigation (Aids to navigation and port configuration).
   - The depth of water including all hazards to navigation and items pertinent to other marine activities.
   - The composition of the seabed.
   - Tides, tidal streams and currents.
   - The physical and chemical properties of the water column.

b. The processing of this information in order to create organized databases to facilitate the production of thematic maps, nautical charts and other documentation for varied uses including inter alia:

- Safety of navigation (includes traffic control and separation schemes).
- Naval operations.
- Coastal management and defence.
- Protection of the marine environment.
- Exploitation of marine resources and laying of submarine cables/pipelines.
- Maritime boundaries definition (Law of the Sea implementation).
- Scientific studies pertaining to the sea and near-shore zone.

1.3.3 Geoscience

Marine geoscience is the study of the material that comprises the coastal zone, the seabed, and sub-sea structures, and of the processes that affect that material. It is concerned with the composition and distribution of sedimentary and non-sedimentary material, as well as the mechanisms of their emplacement. In addition to direct sampling and measurement, its investigative techniques include remote sensing observations (transmission of acoustic signals, measurement of terrestrial gravity and magnetic fields) for determining the physical and chemical characteristics of structures that cannot be directly accessed.

The scope of marine geoscience ranges from the atomic to the planetary. Its findings help explain the shape and variability of the shoreline and of the seabed, placing them within regional contexts that evolve over time frames which span the seasonal to the geological. Coastal and seabed features that represent local hazards to navigation can be understood for the most part as the consequences of geological and tectonic processes. The characteristics of those features may impact not only the determination of maritime boundaries, but also the consequences of certain boundary configurations insofar as they could affect ease of navigation and access to resources.

An appreciation of an ocean basin's tectonic history and framework can be crucial to the delimitation of outer continental shelf limits according to the provisions of Article 76 (see Chapter 5). It is also fundamental to an understanding of the nature, distribution, and value of non-living resources of the seabed, which are addressed in Parts VI and XI of the Convention (Continental Shelf and The Area, respectively).

CHAPTER 2 - GEODESY

TABLE OF CONTENTS

Tables

2.1 INTRODUCTION

In the late nineteenth century, geodesy was defined as “the science of the measurement and mapping of the earth’s surface” (Helmert 1880), and this definition still applies today. As the Earth’s surface is to a great extent formed by the gravity field and as most geodetic measurements depend on this field, the definition of geodesy includes the determination of the gravity field, on and external to the earth’s surface. Moreover, the classical definition is nowadays extended to include the temporal variations of the earth’s surface and the gravity field. In this extended definition, geodesy is part of both geoscience and engineering science (including surveying and navigation), and it can be further divided into global geodesy, geodetic surveying (national and international) and plane surveying. For the LOS, emphasis is placed on geodetic surveying in geographically extended applications, whereas plane surveying dominates in applications over more restricted areas. However, there is a clear trend towards unique global solutions, e.g. for the definition of the Geoid itself, and for geodetic datum definitions.

2.2 THE GEOID

The term Geoid is used to portray the shape of the Earth's surface, and it identifies that surface to which the oceans would conform over the entire Earth if free to adjust to the combined effect of the Earth's mass attraction and the centrifugal force of the Earth's rotation.

Among the Earth’s equipotential surfaces, the Geoid coincides with the mean sea level of the oceans through a process of Least Squares Approximation. The Geoid extends under the continents and differs from an ellipsoid of revolution by vertical distances that are within the order of one hundred metres.

Ignoring for the moment that soundings on charts are referred to a low water chart datum, (a topic that will be addressed in Sect. 2.5) the Geoid is the reference surface for heights (orthometric or dynamic, defined below) used in mapping. As such it is often called a "vertical datum" and the heights referred to it are commonly known as "heights above mean sea level". The practical realization of the vertical datum is normally achieved by accepting a mean sea level at the locations of tide gauges along the seashore. This realization carries with it some inherent errors that may reach well over one metre. The local mean sea level is determined indirectly, by studying the tide-gauge record for a certain time period and is thus tacitly valid for that time period. For a more extensive discussion of these concepts, see for instance (Vaníček, 1991).

Terminological note: the term "vertical datum" is in some surveying circles used to mean one control point, or the whole network of vertical control points (benchmarks) and/or the permanent tide gauges. This usage is somewhat confusing and should be avoided. The Geoid is, of course, not the only vertical datum used. Chart datums, treated in Sect. 2.5, are examples of vertical datums used for compiling nautical charts. Other possible choices of a vertical datum are now being vigorously debated in hydrographic circles due to the need for a precise international reference for digital data.

Before starting to discuss the Geoid itself, the two basic height definitions as they are used in geodesy should be reviewed. "Orthometric" heights are the everyday heights used in surveying practice and in mapping. The orthometric height of a point is defined as the length of the section of the plumb line between the Geoid and the point. Thus, clearly, the orthometric height of any point located on the Geoid equals to zero.

"Dynamic" heights are used whenever it is necessary to deal with phenomena where the laws of physics play a dominant role. This situation is encountered, for instance, in hydrological investigations. The dynamic height is defined in such a way that all the points on the same level surface (an equipotential surface of the earth gravity field) have the same dynamic height. If one point has a larger dynamic height than another point, a fluid will flow from the higher point to the lower point. This is not the case with orthometric heights. The dynamic height of any point located on the Geoid is equal to zero.

Readers interested in learning how levelled height differences obtained from field measurements are transformed into one of the two proper heights, orthometric or dynamic, should consult (Heiskanen and Moritz, 1967, §4; Vaníček and Krakiwsky, 1986, §19.21). Section 2.5.3 below deals with yet another height, "geodetic" height, which is not used in practice because it refers to the horizontal datum.

The Geoid is probably the most important surface in geodesy. Generations of geodesists have been computing the Geoid from different kinds of measurements ranging from the astronomically determined deflections of the vertical to gravity, from satellite orbital analysis to satellite altimetry, striving for an ever increasing accuracy. Two broad families of techniques are used for the Geoid computations and, correspondingly, two broad families of results are available: global solutions and regional solutions. Global solutions are available in terms of equations (involving a number of functions), whereas regional solutions are given by numerical values on a chosen geographical grid, see for instance (Sideris, 1994). In both cases, the Geoid is described at each point by its departure, called the "Geoidal height", "Geoid height" or "Geoid undulation", from a horizontal datum, usually a global horizontal datum, which will be explained in Section 2.4.3.

When one wishes to use the Geoidal height, it is thus absolutely essential to know to which horizontal datum it is referred. This may sound paradoxical to readers who have not been much exposed to geodesy. It shows, in its simplest form, that the Geoid supplies the vital link between horizontal and vertical positions. Geoidal heights are an indispensable component in converting horizontal positions and heights (above the sea level) into true three-dimensional positions.

The short wavelength features (up to several hundred kilometres) of the Geoid are now becoming quite well known, with errors in decimetres, or even centimetres in some parts of the world. Long wavelength features, obtainable only from satellite orbit analysis, are still not known to the same accuracy. However, data from on-going new satellite missions are rapidly improving the available information. (See below.) Regional solutions, capable of depicting much shorter wavelength features, are usually much more accurate than global solutions where errors can reach several metres, particularly in the mountains. This is due to the finiteness of the functional series that describe the global solution (Vaníček and Christou, 1994; Chapters 3 and 6), which smooth out the shorter wavelength features. If the Geoidal height is to be used in any calculations, its uncertainty, both systematic and random, should also be known and should be taken into account.

At sea the Geoid can now be estimated directly by satellite altimetry. Several satellite altimetry missions have been flown in the recent past. The most recent mission, yielding the most accurate sea surface, is the TOPEX/POSEIDON described in (AGU, 1994). Because satellite altimetry measures the height of instantaneous sea level above a geocentric datum - see the next section -

the Geoid obtained from this system is only approximate, accurate to perhaps a metre.

A more precise and homogeneous determination of the long-wavelength features of the Geoid is being realized by the on-going and planned dedicated satellite gravity missions CHAMP, GRACE and GOCE. In this way, it is expected that the Geoid will be determined from space to 1 cm accuracy all over the Earth at a resolution of 100 km ((Seeber 2003) and (www.esa.int/export/esaLP/goce.html)).

2.3 THE ELLIPSOID

The Geoid, being a very irregularly shaped surface (Figure. 2.1), cannot be defined by a simple mathematical expression. In theory, it should be possible to make calculations on any surface, whether regular or irregular, but the formulae involving the Geoid would be so complicated as to be prohibitive in practice. Therefore for geodetic and mapping purposes, it is necessary to use a geometric shape that closely approximates the shape of the Geoid (Figure. 2.2). There are several "reference ellipsoids" in use, most of which give very satisfactory results in certain localities but not in others (Figure. 2.3).

When we construct a geocentric ellipsoid which fits the Geoid in the best least squares sense, the departure of these two surfaces is no more than 100 metres. The separation between the two surfaces is the Geoidal height. The Geoid extends under the continents and it may also be mathematically defined as so many metres above (+N) or below (-N) a given ellipsoid (Figure. 2.4).

$$h = H + N \qquad \text{Equation 2-1}$$

where:

h = geodetic height (height above the ellipsoid)
H = height above mean sea level
N = Geoidal height

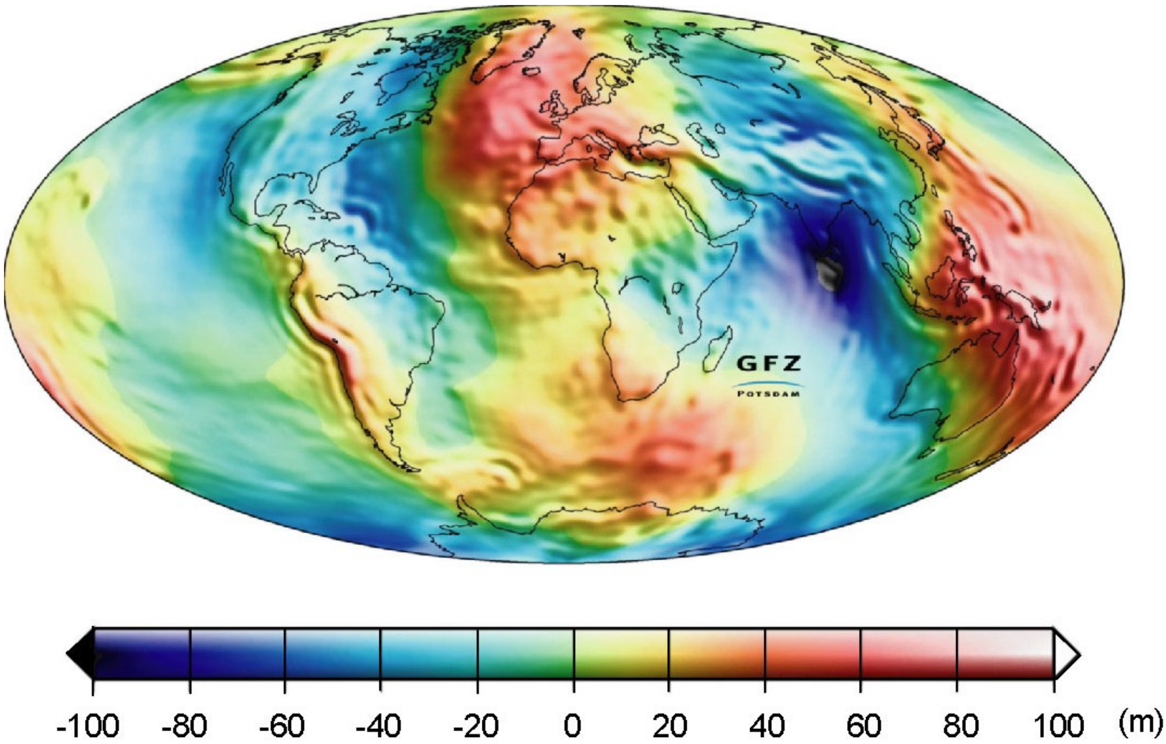


Figure 2.1 - Geoid heights, derived from a combination of surface gravity data with the results of the CHAMP and GRACE Satellite Missions (EIGEN-GRACE02S).
Source: the GRACE Mission, Department 1, GFZ, Potsdam.
http://www.gfz-potsdam.de/pb1/op/grace/index_GRACE.html

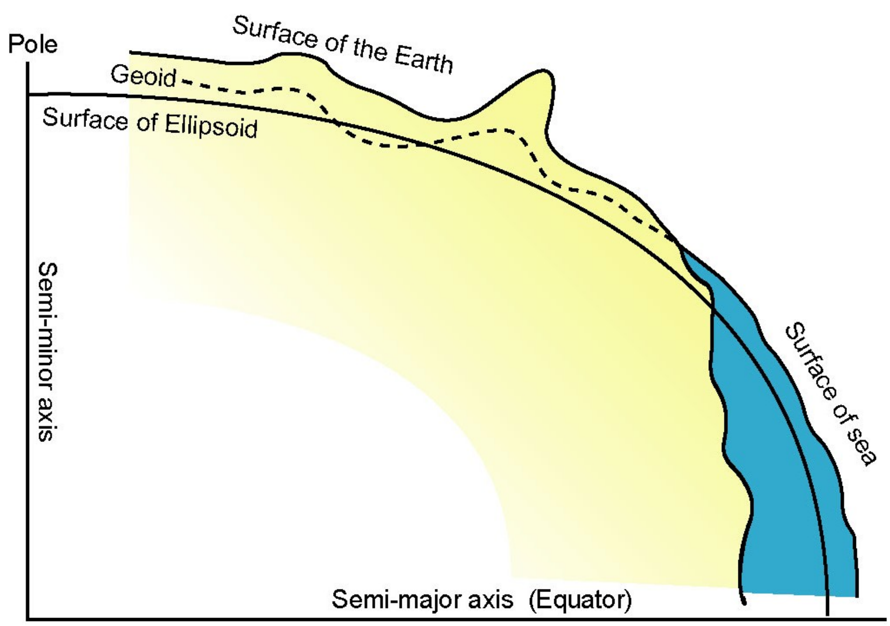


Figure 2.2 - Geodetic representation of a section of the Earth

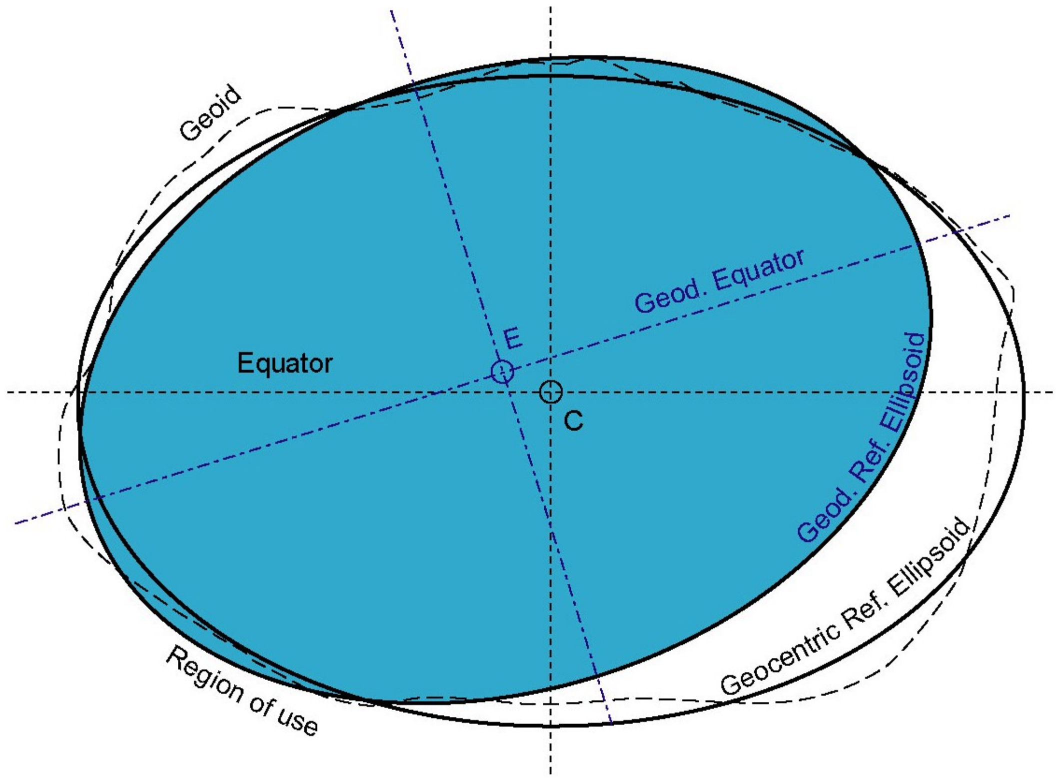


Figure 2.3 - Geocentric and Regional Ellipsoids

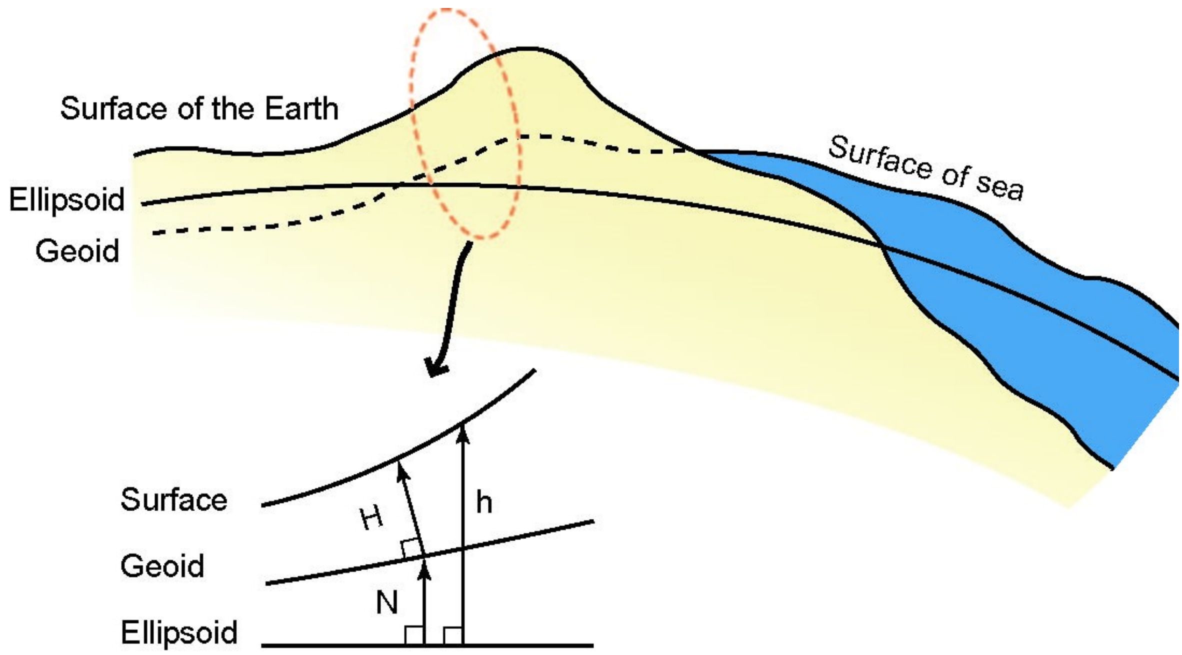


Figure 2.4 – Geodetic Height (h), Orthometric Height (H) and Geoidal Height (N)

2.4 GEODETIC DATUMS

The geodetic ellipsoid of revolution defined in Section 2.3 is often used as a reference for horizontal positions, in terms of latitude ϕ and longitude λ. In this context, the ellipsoid becomes known as the *horizontal datum*. Since there is some ambivalence in geodetic circles about the operation, let us first explain the relation between a "reference ellipsoid" and a "horizontal datum", geocentric or regional/local. A horizontal datum is a reference ellipsoid. But for the reference ellipsoid of a selected size and shape to be of any use as a coordinate reference surface, its position and orientation within the earth have to be uniquely defined. There are several techniques for positioning and orienting the reference ellipsoid within the earth and the reader will find a detailed description of these techniques in (Vaníček and Krakiwsky 1986; § 18. 1). Since a horizontal datum is nothing else but a properly positioned and oriented reference ellipsoid, we often use these two terms interchangeably when there is no danger of confusion. In some surveying circles, the term horizontal datum (geocentric or local) is understood a little differently. There, it is used for the totality of the reference ellipsoid and the geodetic control network points. This usage is somewhat confusing and should be avoided.

The geodetic coordinates, consisting of the horizontal coordinates, ϕ and λ, and the above introduced geodetic height h, can be readily converted to Cartesian coordinates X, Y, Z, referred to the minor and two major (equatorial) axes of the ellipsoid (e.g. (Heiskanen and Moritz 1967, Sect. 5.3); see also Figure. 2.5). These axes are directed approximately to coincide with:

- The spin axis of the earth;
- The direction of the intersection of the Greenwich meridian plane with the equatorial plane;
- 90º to both the above

The axes have their origin, naturally, at the centre of mass of the earth. This <u>geocentric Cartesian system</u> is used today in positioning by modern space techniques.

The inverse transformation (i.e. from Cartesian coordinates to geodetic coordinates) is less straightforward (e.g. (Hoffman-Wellenhof et al. 2001, Sect. 10.2.1)) In the geodetic literature there are numerous iterative solutions e.g. (Heiskanen and Moritz 1967, Sect. 5-3) and (Sjöberg 1999), approximate closed solutions and exact closed solutions. The best solution of the last type is probably (Vermeille 2002).

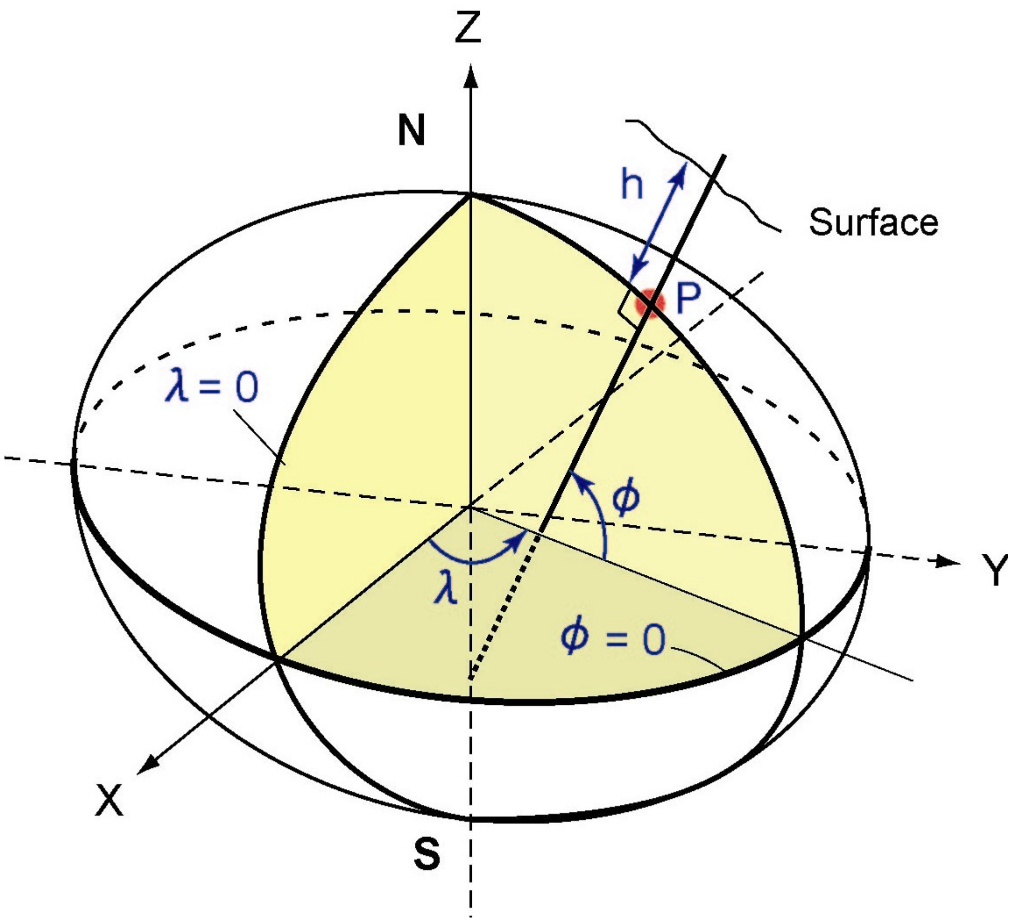


Figure. 2.5 - The meridian ellipse, illustrating the relation between geocentric Cartesian coordinates (X, Y, Z) and the geodetic coordinates ø, λ and h.

2.4.1 Ellipsoids and geocentric datums

In the past, it was not possible to realize geocentric systems, so regional and local datums were used instead. They are still in use today over most of the Earth's surface. These non-geocentric geodetic datums used ellipsoids of various shapes and sizes, positioned and oriented with respect to the Earth in some well-defined manner. Classically, this had been done by the following specifications:

- The ellipsoid normal to be oriented (this is done by specifying the latitude and longitude of the datum point);
- The orientation of the datum point's ellipsoid normal with respect to the local Gravity vertical (this is done by specifying the deflector of the vertical components at the datum point);
- The Geoid-ellipsoid separation at the datum point (often selected to equal zero);
- The orientation of the datum with respect to the earth (this is done by selecting a value for the geodetic azimuth of a line of the network originated at the datum point).

For reasons no longer valid today, the size and the shape of the ellipsoid and the position and orientation of the geodetic datum were often selected so as to optimize the fit of the datum to the Geoid in the area of interest. Other ways of positioning and orienting the datum are now available. The trend for the future, however, is to replace the geodetic datums by one geocentric horizontal datum valid globally (Figure. 2.6).

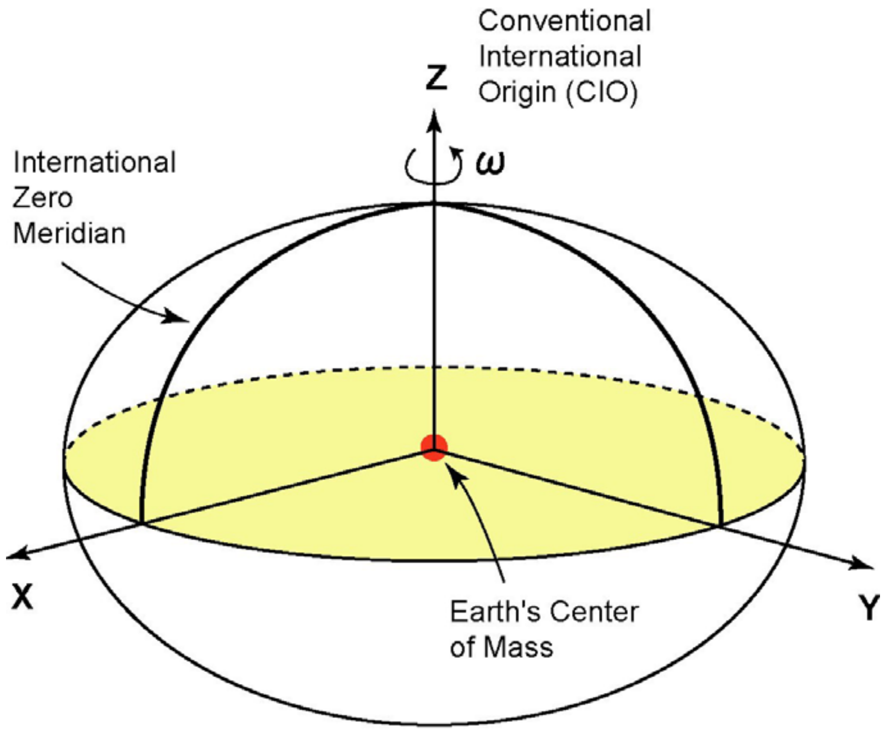


Figure 2.6 - Geocentric Horizontal Datum

2.4.2 Local Datums

In order to reach the closest fit in the area of interest between the Geoid and the ellipsoid, many countries have developed a geodetic datum establishing the location of the origin and the ellipsoid in use. Although this choice should be a technical one, other non-technical factors may affect the selection. A list, not exhaustive, of geodetic datums is shown in Table 2-1. Most maps and most modern medium and large-scale charts indicate the geodetic datum used. Older charts may not always include this information; however it may be obtainable from the authority that published the charts.

As a consequence of the use of coordinate systems based on different geodetic datums, the same point shown on charts compiled by different countries may be assigned different values of latitude and longitude. These differences could have a significant effect on the positions. This is of particular importance when applying the equidistance method in the construction of maritime boundaries. To avoid any possibility of cartographic incompatibility when positioning maritime boundary delimitations, it is recommended that a common geodetic datum be adopted, and the adjustments necessary to pass from one geodetic system to the other one be noted and quantified.

If this transformation is impossible or inconvenient, the best solution is to agree on the use of common charts during negotiations.

2.4.3 Regional Datums

A great deal of work has been done world-wide to establish the relationship between different geodetic datums, or to define a common datum useful for large areas.

In many parts of the world it is now possible, with relative ease, to convert coordinates on one datum to the correct values on another, and in some areas a geodetic datum has been established (with ellipsoid parameters and origin selected to provide the best fit to the Geoid surface in the region) so as to transform all national datums in the region to a common one.

2.4.3.1 Summary of Regional Datums

The regional datums situation is summarized below:

EUROPE

In addition to their national systems, most European countries relate their coordinated stations to the European Datum (ED-50) based on extended traverses and least square adjustments from an origin in Potsdam. Successively a limited number of countries are redefining new standards.

Geodetic Datums	Countries
ED-50	Austria, Belgium, Denmark, Finland, France, F.R.G., Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland.
ED-87 (UK)	Austria, Finland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland

NORTH AMERICA

The North American Datum 1927 (NAD-27) was based on triangulation with the origin at the Meade Ranch-Kansas. North American Datum 1983 (NAD-83) was defined as a geocentric system, compatible with the TRANSIT satellite system, and, for all practical purposes identical to the Geodetic Reference System (GRS-80) and the World Geodetic System (WGS-84).

Geodetic Datums	Countries
NAD-27	United States (CONUS), The Bahamas, Canada, Caribbean, Central America, Mexico.
NAD-83	United States (CONUS), The Bahamas, Canada, Caribbean, Central America, Mexico.

SOUTH AMERICA

The Provisional South American 1956 was the first common datum established in the region. Subsequently the South American Datum, SAD-69, was defined with origin in Chua (Brazil), but it is not yet completely implemented.

Geodetic Datums	Countries
Provisional SA-56	Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela.
SAD-69	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela, Trinidad & Tobago.

AFRICA

In Africa there are three main datums implemented: ADINDAN, ARC 1950 and ARC 1960. An African system, ADOS, exists but it is not yet in use.

Geodetic Datums	Countries
ADINDAN	Ethiopia, Mali, Senegal, Sudan.
ARC 1950	Bostwana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe.
ARC 1960	Kenya, Tanzania.

ASIA

The Indian Geodetic System is implemented in a large area of Asia, while in the Far East the TD (Tokyo Datum) exists.

Geodetic Datums	Countries
INDIAN	India, Bangladesh, Nepal, Thailand, Vietnam.
TD	Japan, Korea, Taiwan

AUSTRALIA

The AGD 1966 and AGD 1984 are the Australian Geodetic Datums defined for Australia (including Tasmania).

The major geodetic datums are illustrated in Figure. 2.7.

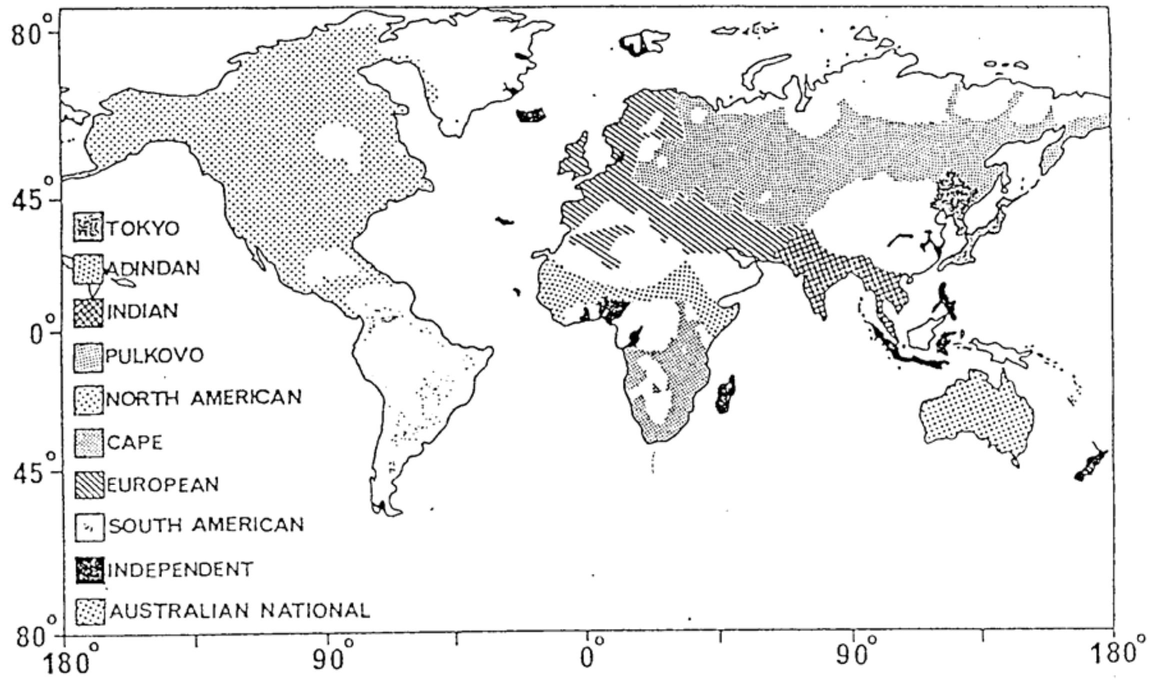


Figure 2.7 - Regions of use of major geodetic datums (From Vanicek and Krakiwsky 1986, p. 101). The remaining areas of the world use locally defined datums.

2.4.3.2 List of Local and Regional Datums

Transformation parameters between the local and regional geodetic datums (shown in Table 2 – 2 on page Chapter 2 - 28) and WGS 84 (GRS 80) have been determined by the U.S. Defense Mapping Agency, now known as the National Geospatial-Intelligence Agency (NGA).

2.4.4 Geocentric Datums (Worldwide Datums)

The advent of dedicated geodetic satellites brought in the real global (or international) age of geodesy. The use of satellites for navigation and geodetic positioning was immediately recognized and universally adopted.

Until a few decades ago, in order to determine the position (in latitude and longitude) of a known point, it was necessary to make astronomical observations that were affected by the Earth's gravity field. Each country tended to adopt the reference ellipsoid which best fit these local observations. They were then able to draw, with minimum distortion, local charts referred to a local datum.

Satellite positioning methods can be used in areas where the traditional geodetic procedures are more costly. They have allowed the development of a unique set of geodetic co-ordinates on a global datum. The first global datum was defined in 1960 by the United States, and was known as the World Geodetic System (WGS 60). For the first time, it provided a truly geocentric worldwide coordinate system for global mapping, charting and navigation. Refinement of the model has been continuous. The most recent version of the system implemented is the WGS 84, which was developed to replace the previous WGS 72.

At its General Assembly in Canberra in 1979, the International Union of Geodesy and Geophysics (IUGG) accepted the proposal of its constituent body, the International Association of Geodesy (IAG), for a new Geodetic Reference System (GRS 80) to be used as an official reference for geodetic work, in place of the earlier GRS 67 (see note below). The GRS80 (Moritz 2000) is the recommended geocentric geodetic system that should normally be used by international organisations. A geodetic reference system is defined by specifying:

1) the orientation of the geocentric Cartesian coordinate system,
2) the size and shape of the reference ellipsoid,
3) the system's rotation rate, and
4) the "normal gravity field".

It may be noted that the word "geocentric" implies the position of the coordinate system's origin at the earth’s centre of gravity. In the applications of geodetic positioning that are described in this Manual, only the geometrical aspects of the reference system are actually needed.

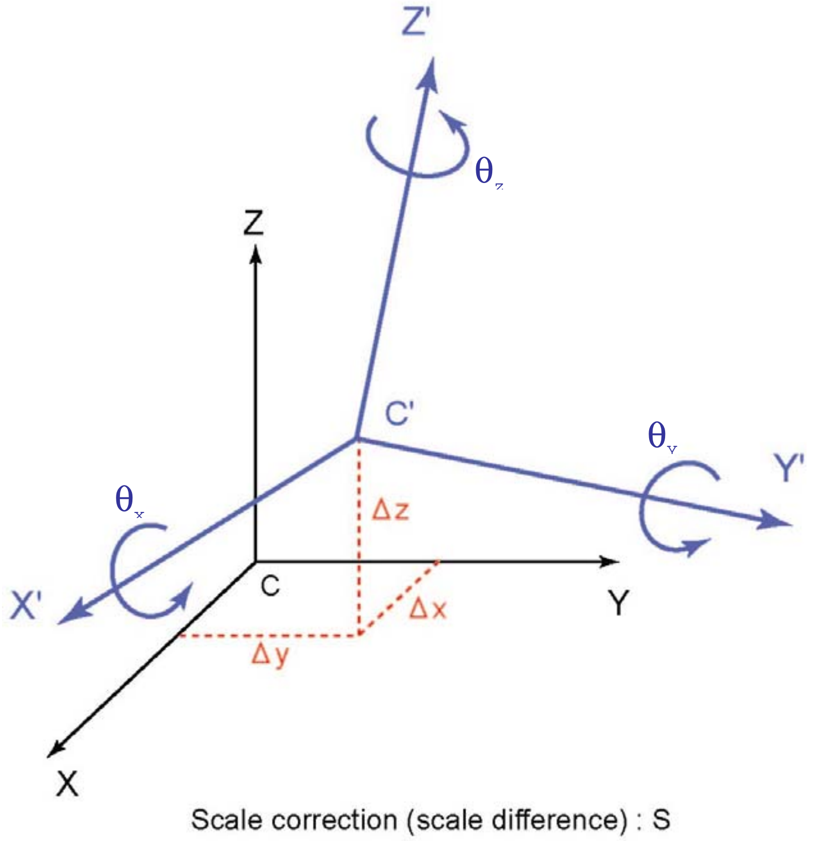
Most techniques for determining positions (coordinates) do so by relating to positions that are already known. To determine a position in a specific coordinate system therefore usually requires knowledge of some positions in that coordinate system. In the case of GRS80, its definition includes no position references, and this is where WGS84 becomes useful. The WGS 84, which includes coordinates (positions) of some of the satellite tracking stations, is one of the practical realizations of GRS80 (Defense Mapping Agency, 1987) and as such should be used here. Thus by using the WGS 84, countries really conform to the IAG's recommendation that GRS80 be used for geodetic work. Note that NAD 83, the North American Datum horizontal datum, is another realization of GRS80.The opportunity to replace WGS 72, which is still adequate, arose from the availability of new data, theory and techniques.

NOTE: GRS 80 is defined by (Moritz 2000) in the publication by IAG (International Association of Geodesy) named "THE GEODESIST'S HANDBOOK", while WGS 84 is defined by DMA (1987). Observe that there is a slight difference in the reference systems between GRS 80 and WGS 84. In 1983 an agreement was reached within the IHO to adopt the World Geodetic System as a global reference system for nautical charts, and two Technical Resolutions (B1.1 and B2.10) were adopted.

2.4.5 Transformation between Geodetic Datums

To convert coordinates from one datum to another one it is necessary to know the datum transformation parameters. Usually the transformation can be represented by a so-called Helmert transformation, in which case the parameters consist of 3 translation components (Δx, Δy, Δz), 3 rotations (θ_x, θ_y, θ_z) and a scale correction (see Figure. 2.8). The rotations are usually very small and are often neglected in common use. Since the parameters of transformation between two geodetic datums cannot be determined directly, coordinates (positions) of a set of identical points on both datums must be used to determine them. These positions are always distorted due to the inevitable presence of both systematic and random errors. This fact makes the determination of transformation parameters very tricky and a great deal of care must be taken to do it properly. For an in depth study of the problem the reader is referred to (Vaníček, 1992). IHO Special Publication No. 60 (S 60) lists transformation parameters world wide for transformations between numerous local (regional) datums and WGS84.

Note that the parameter called "scale correction" or "scale difference" is not a real transformation parameter for two datums. The "scale correction" reflects the (average) difference in scales of the coordinates used for the parameter determination. It is thus the simplest mathematical model for the difference of systematic distortions in the two sets of coordinates.



$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} s & -\theta z & \theta y \\ \theta z & s & -\theta x \\ -\theta y & \theta x & s \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} \Delta x \\ \Delta y \\ \Delta z \end{pmatrix}$$

Figure 2.8 - Set of datum transformation parameters

The values of the Transformation Parameters will appear to change from location to location depending on the variation in the error in position. But these variations are only virtual: the transformation from one Datum to another consists of two components, the parameters themselves and the component reflecting the errors in the position. In some cases (NIMA, 1997) the two components are combined into one transformation. It should also be evident that a readjustment of positions on one or both datums will result in changes in the Transformation Parameters.

The transformation from a local system to the WGS datum can be performed as follows:

a) Where the density of stations of the existing local geodetic network is sufficient, the updating to WGS may be achieved by placing a geodetic satellite receiver at the local geodetic positions where local datum coordinates are known, and recording the satellite measured positions, which are subsequently processed to attain the required level of geodetic precision. From these coordinates the difference between the local datum and WGS datum can be determined.

b) If the local geodetic network is not sufficient and has to be extended, new positions may be obtained by translocation from a station whose WGS coordinates are known. One satellite receiver is placed on the known station and a second placed on the new station. Simultaneous readings are taken, and once again processed using the precise satellite ephemerides and coordinates of the new station obtained.

These two methods, which are relatively quick and not subject to weather, produce accurate coordinates on the WGS Datum and precise parameters for the relationship between local and WGS datums.

It should be noted that mariners who use GPS receivers for navigation purposes can establish their position in coordinates related to the Global Reference System (i.e. WGS) used for determining the positions of maritime boundaries. For the above reasons, the use of a Global Geodetic System is recommended as the basic international chart reference system necessary to cope with the problem of defining boundaries at sea.

2.5 VERTICAL DATUMS

To provide the mariner with a margin of safety in terms of depth measurement all charted depths are referred to chart datum, which is equated to the datum of tidal predictions and defined by the IHO as a plane so low that the tide will not frequently fall below it. Thus, unlike heights on land maps, which are normally referred to Mean Sea Level, depths on charts are referred to a low water level. For the determination of chart datum it is necessary to observe heights of points above the low water. Thus the height of low water below the mean sea level must be determined. This is done by analyzing the records of tide gauges from the vicinity of the points of interest, which requires a specific expertise. Note that the local sea level variations are caused not only by sea tides (also called astronomical tides in hydrography), but also by other phenomena such as storm surges, currents, wind action, barometric pressure variations, thermohaline changes, etc. Even though these non-tidal variations may be occasionally as large as the tidal variations, they are not normally considered in the analysis. For more detailed discussion the reader is referred to monographs such as (Hill 1962; Warren and Wunsch 1981), or the overview paper by (Stommel 1963).

Additionally, sea level and land heights undergo secular changes at varying rates (as well as periodic changes which do not present a real problem because they can be averaged out, one way or another) see (Lambeck 1988). While the sea level rises globally by 1 or 2 mm per year, the land rise or subsidence may reach several centimetres per year and more, in particularly active regions. This may seem trivial along most coasts but when the coast has a low gradient, the effect of such changes may be fairly significant. For example, through the post glacial rise of the earth's crust in the Hudson Bay area, Canada is steadily gaining many hundreds of square kilometres of territory each year (Walcott, 1972). A similar situation exists in the Bay of Bothnia in Fennoscandia (e.g. Lambeck, 1988, Sect. 10.5).

Transformations between different kinds of vertical datums are a fairly involved problem. Various approximate methods exist. For a reader interested in a more technical exposure of the problem we recommend the paper by (Vaníček 1994). A practical experience with a transformation in Fennoscandia has been described, for example, by (Pan and Sjöberg 1993; Nahavandchi and Sjöberg 1998). Bursa et al. (2004) derive the transformation parameters between a global vertical datum and four regional vertical datums.

The vertical references for both land maps and nautical maps/charts are based on sea levels. These levels are obtained using tide gauges, which are installed at strategic points along a coastline and can range in form from simple graduated staffs to automatic recording instruments.

On land maps, mean sea level (MSL) is normally used as the reference level for all heights. On nautical charts, a low water level (chart datum) is normally used as the reference level. All depths shown on a nautical chart, regardless of the stage of tide when they were obtained, are corrected to what they would be at low tide. Thus under normal circumstances, the mariner can be assured that the depth of water is unlikely to be less than shown on the chart. By adding to the charted depth the observed or predicted water height at the moment of passage, the actual depth can be determined.

Establishing a suitable chart datum can be complicated because low water is not a fixed level. The range of the tide varies from day to day, month to month, and year to year. The factors primarily responsible for these variations are mainly associated with particular lunar and Earth movements including:

Phase of the Moon - When the moon and the sun are in alignment, at New Moon and Full Moon, their tide producing forces complement each other. This results in tides of larger than average ranges, known as spring tides, occurring approximately every two weeks. Neap tides, on the other hand, occur during the phases of the first and third quarters of the moon and have smaller than average ranges, since the forces of the sun and moon are in opposition to each other.

Elliptical orbits of the moon and earth - When the moon is at perigee, it is nearest the earth and its tide producing forces are larger than average since the gravitational attractions of the sun and moon are inversely proportional to the square of their distances, and the tide producing forces are inversely proportional to the cube of their distances from the earth. High water rises higher and low water falls lower than usual when the moon is at perigee. Conversely, when the moon is farthest from the earth, at apogee, lunar tide ranges are less than average.

The moon's changing declination - The closer the moon is to being over the equator in its orbit, the more similar the morning and afternoon tides will be. However, as the declination of the moon increases, the greater the differences become. Successive high and successive low waters become more unequal in height. This phenomenon is known as diurnal inequality. Tides are classified according to the degree of diurnal inequality that they display.
While these three factors affecting tidal range occur on a global basis, they do not occur in equal proportions everywhere. One region may be predominantly influenced by the moon's phase while

another region is most significantly affected by the changing declination of the moon. The sun has similar but lesser effects on the tidal characteristics, while other astronomical bodies have even smaller effects.

Tidal ranges can also vary within relatively short distances along a coastline and this is due largely to coastal configuration. Theoretical lunar tides are modified by coastal physiography, sometimes dramatically. It is the interaction of the tidal wave with the shoreline and shallow near shore water, the river estuaries and the bays, that produces tidal features as we know them. Due to this coastal influence, it is often the case that different types of tides are found in close proximity to each other along a coastline.

Owing to the many varied tidal characteristics existing throughout the world, a precise, scientific definition for chart datum, which could be used universally, has not been agreed upon. (Over the past 200 years, different countries have adopted different methods for computing chart datum, depending usually on the type of prevailing tide). As yet, only basic guidelines exist. In accordance with an International Hydrographic Organization Resolution of 1926, chart datum should:

(i) be so low that the water will but seldom fall below it;

(ii) not be so low as to cause the charted depths to be unrealistically deep; and

(iii) vary only gradually from area to area and from chart to adjoining chart, to avoid significant discontinuities.

In very basic terms, a chart datum can be defined as the mean of specific low waters over an extended period of time. The time period should ideally be 19 years or more, in order to include all the significant astronomical variations. Opinions vary, however, in terms of which low waters should be used to arrive at this mean value, and as a result, many different precise definitions are currently in use. For example, some countries define chart datum as the mean of all the lower low waters (MLLW) over a specified 19 years period. Others use a chart datum called lower low water large tides (LLWLT), which is defined as the average of the lowest low waters, one from each of 19 years of prediction. Yet others use the lowest low water spring tide (LLWST), which is the average of the lowest low water observations of spring tides, over a specified period. The most conservative use the lowest astronomical tide (LAT), which is the lowest level that can be predicted to occur under average meteorological conditions and under a combination of astronomical conditions.

The differences between the various chart datums and mean sea levels that have been established throughout the world have significant implications in terms of boundary delimitation. The contour of zero depth on the chart corresponds to the level of chart datum. It is considered as the charted low water line, and is the line from which maritime boundaries and limits of jurisdictional zones are measured.

The fact that there are different levels of Chart Datum means that adjacent or opposite States may use different levels at which to establish their baselines. Consequently, differences in the development of equidistance lines can result. It is necessary to take into account the possibility of different datums existing between opposite or adjacent States, such as the case when one State may utilize Mean Low Water Springs (MLWS) as the datum, while another State may utilize Lower Low Water Large Tides (LLWLT). In that situation, a low tide elevation is recognized on the chart of one, but not on the other.

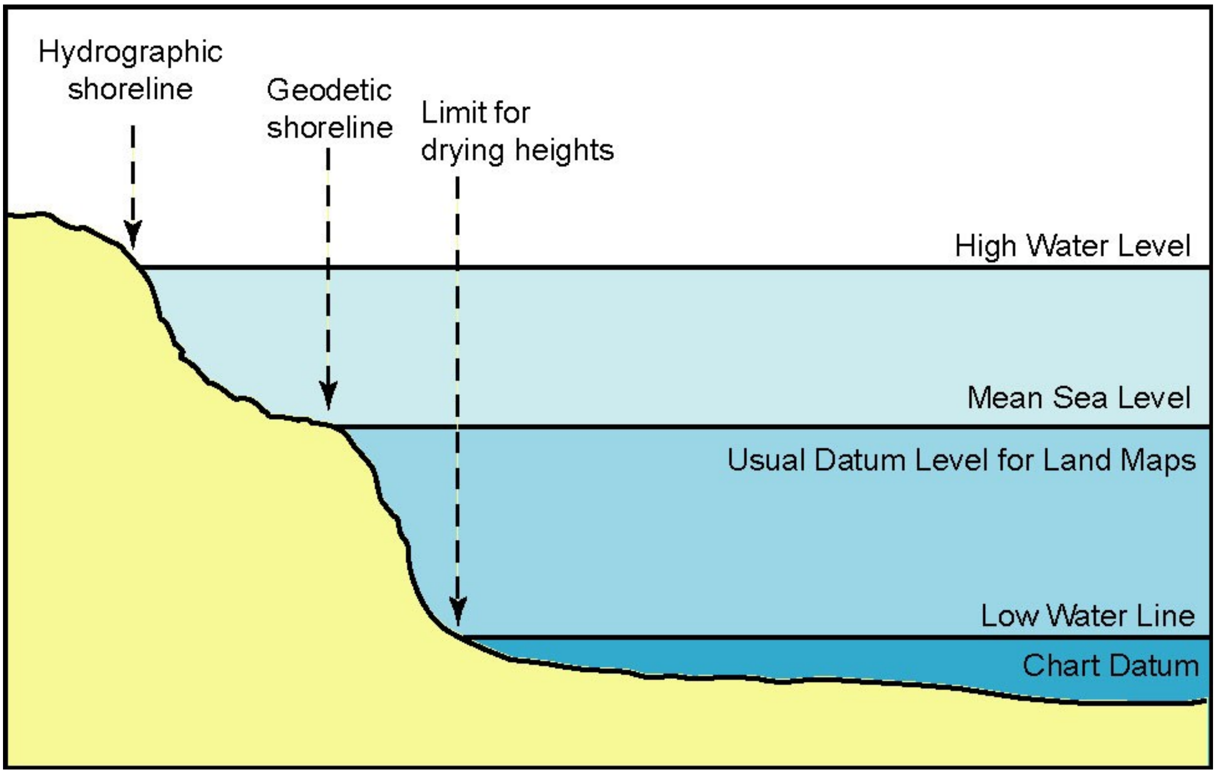


Figure 2.9 - Vertical Datums

Considerable differences may also occur in areas where rocks, islands or reefs, exposed at low tide, are used as baseline points. The choice of the level of chart datum may decide whether they are charted as features permanently below water and thereby eliminated from boundary delimitation calculations, or whether they are charted as low-tide elevations for possible inclusion in such calculations.

Just as the precise definition of chart datum is crucial in boundary delimitation, so too is the accuracy of the data used in the actual calculations. The accuracy of the vertical datum depends on: the length of the tidal records; the remoteness of the area to be delimited from the secondary station, i.e., the closest place where the tide has actually been observed; and the remoteness of that secondary station from the primary station.

In arriving at a reliable, accurate chart datum it is essential to have a good knowledge of the nature of the water level fluctuations for that area. This knowledge is obtained through water level observations of at least one year, but ideally much longer.

At many coastal sites, such as major ports, tide gauges are operated continuously. These sites, which are variously called Primary Control Tide Gauge Stations or Reference Ports, etc. have been in operation around the world. The extensive data that have been gathered at these sites provide a sound basis upon which to establish an accurate chart datum elevation. However, it would be financially impossible and often impractical to operate permanent tide gauges at all locations where chart datum is required. At various points between the primary stations, therefore, secondary stations are established. Chart datum at these sites is derived using much shorter periods of data, often as little as one month. This data is analyzed through comparison with simultaneous observations at a nearby primary tide gauge. Obviously, an adequately dense network of primary stations is vital because these comparisons can only render accurate results if the tidal characteristics at the primary and secondary stations are very similar and there are no significant local effects due to river discharges, extensive shoal areas, etc. Along extensive and diverse coastlines, the remoteness of a secondary port from a suitable primary station is often a problem, which can sometimes adversely affect the accuracy of chart datum determination.

The suitability for boundary delimitation purposes of a chart datum that has been derived from only 30 days of data, or of a chart datum derived for a location which is remotely situated from a primary tide gauge location, may sometimes be questionable in terms of accuracy. When datums have been properly established, it is the practice to provide one or more reference monuments, known as bench marks, permanently set in the ground, ideally in bedrock, in order that the elevation may be recovered at some later date. In certain parts of the world care must be taken, if there is a very lengthy period between measurements, that the level of the land and the level of the sea have not moved relative to each other due to isostatic uplifting of the land.

2.6 SURVEYS

2.6.1 Introduction

In order to determine maritime boundaries, it may be necessary to perform surveys both on land and at sea, as follows:

- Geodetic and topographic surveys.
- Tidal and oceanographic surveys.
- Bathymetric surveys.
- Geoscientific surveys.

This section will focus on land operations that make use of geodetic methodologies.

The use of geodetic (and topographic) surveys and calculations may be required in the following cases:

- Determination of the low-water line, which defines a coastal state’s normal baseline and/or the base points of a straight baseline;
- Positioning and/or verification of the geodetic coordinates of points and benchmarks;
- Conversion from one geodetic datum to another, or definition of a common datum;
- Determination of the datum that was used for original positions, and which may not have been properly or adequately documented;
- Re-adjustment of ancient and/or distorted surveys.

2.6.2 Determination of the Baseline

Generally the baseline from which territorial waters are measured corresponds to the low water coastline that is indicated on the official nautical charts of the coastal State (see Section 4).

Situations arise where the coastline is not defined clearly, or where it is improperly described on official charts on account of marked variations due to recession or other phenomena, such as erosion or accretion. In that case, a new geodetic survey may be desirable to determine the positions of the points that define the low-water line.

Before starting, the State should decide which system of baselines it wishes to adopt, i.e. normal or straight. If both will be used, the State needs to determine the sections of coast to which each will apply.

All necessary documents that relate to the coastal zone of interest should be assembled, i.e. charts, list of geodetic points, aerial photographs, etc. It is also important to verify that tidal stations exist and that they are operating in that zone. It is necessary to define the Vertical Datum (see Section 2.5), as well as the horizontal datum in use.

2.6.2.1 Field Reconnaissance

Field reconnaissance is used to identify and select those points along the coast that will be used to define the baseline. Such points may consist of turning or terminal points of a straight baseline system, or they may describe the low-water line that defines a normal baseline. Off-lying rocks, islands and low-tide elevations are particularly important in this respect. It is also necessary to locate all geodetic control points in the area, which may be used to reference the baseline points.

Where the coastline is deeply indented or fringed with islands with numerous embayments, headlands and off-lying rocks and islands, and when it is planned to use a system of straight baselines, care must be taken to carry out a detailed reconnaissance in order to select the proper points. An accurate, large-scale chart is most desirable for this purpose, but if one is not available, other maps and aerial photographs may be used.

The field reconnaissance may involve many hundreds of points. A field survey is not normally carried out, but it is advantageous if some of the points can be connected to the geodetic network and become themselves geodetic reference points.

Article 7 of the LOS Convention indicates the required geographical conditions that must be satisfied prior to employing straight baselines. However, considerable interpretation has taken place on paragraph 3 concerning the stipulation that “the drawing of straight baselines must not depart to any appreciable extent from the general direction of the coast". Figure 2.10 demonstrates just some of the possible choices that may exist on a fictitious length of coastline.

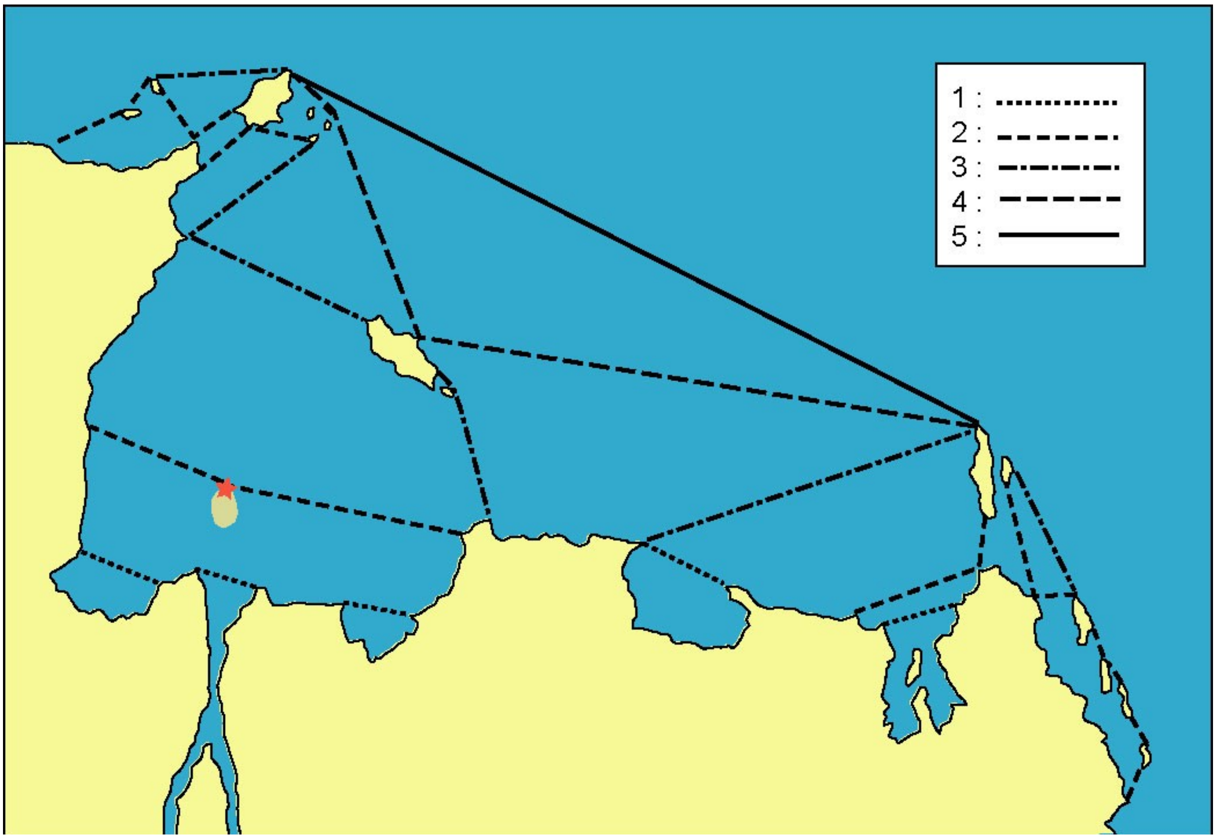


Figure 2.10 - Different interpretations of general direction of the coast and selection of straight baselines

2.6.2.2 Terrestrial Geodetic Measurements

It is necessary to establish horizontal control by means of geodetic measurements when determining the position of the low-water line or of the points that define the straight baselines.

A study of existing charts and maps, complemented by field observations, is essential for examining the configuration of the land and coastline, and to note the existence of established geodetic control points and benchmarks.

In most countries a system of primary first order control will already have been established. Monuments made of concrete, bronze or other permanent substance will mark the physical positions of this control. From these points lower order control points must be established in order to define precisely the geographical location of the coastline and other features of importance to the delimitation.

As the low-water line is determined by the height of the tide it will also be necessary to establish vertical control. This will be achieved through levelling and the use of tide gauges.

Horizontal control may be extended from the primary control by any of several methods. Historically, this has been achieved through triangulation, traversing, and trilateration, but satellite methods are used almost exclusively today. Traversing consists of measuring a series of angles and distances. In all cases, traverses should be closed on another known primary point so that any errors may be determined. Triangulation and trilateration should ideally be in the form of braced quadrilaterals, polygons or other geometric figures that permit internal checking. Standards of measurement to achieve certain orders of control are available in many countries and should be followed.

The "terrestrial horizontal geodetic positioning” described in this section is sometimes described as “relative”: it determines the horizontal positions of new points on the coastline with reference to the horizontal positions of existing geodetic control points. As a consequence, the new positions are subject to all the position errors contained in the existing geodetic control network, plus all the errors contained in the new measurements. This is known as the "propagation of errors", or propagation of positional uncertainties.

These uncertainties are of two different kinds (assuming that gross errors have been already eliminated): random and systematic, the latter being often referred to as "systematic distortions". Each of these uncertainties propagates differently: while the random uncertainties tend to propagate at a slow rate with the distance or its square root (particularly in a well braced network with lots of redundancies), see for instance (Vaníček and Krakiwsky, 1986, §18.3), systematic distortions usually propagate at a higher rate. In networks composed of terrestrial observations, i.e., ‘older’ networks adjusted with respect to the "point of origin", random uncertainties propagate radially from the origin, while systematic distortions have a regional character. Either of the two components may reach many metres, even several tens of metres.

In geodetic practice, the random error component at each point is described by an elliptical "confidence region" also called an "absolute error ellipse". The larger the error ellipse, the larger will be the random positional uncertainty. The absolute error ellipses grow in size with distance from the origin of the network. In more modern networks, where the terrestrial observations are adjusted together with some selected satellite positions (see Sect. 2.6.3; possibly also with position differences determined by the very accurate radio astronomical technique known as "Very Long Baseline Interferometry", (VLBI)), absolute error ellipses have more homogeneous sizes (Vaníček and Krakiwsky 1986; § 18.3). In order to achieve a satisfactory result in such combinations, care must be taken to eliminate likely systematic discrepancies between the different types of data.

Unlike random uncertainties, mathematical formulae of one kind or another can model systematic distortions of a control network. This of course requires a specialised knowledge of the network, and should be done only by responsible national agencies; for an example see (Junkins 1991).

The user of a control network should be aware of the positional uncertainties of the points he wishes to use, including the systematic distortions where known. The best sources of information on these are the pertinent national agencies. The user, having disposed of the known systematic distortions, should obtain the part of the "covariance matrix", cf., for instance (Mikhail 1976: §4.4.2), pertaining to the points he wishes to use from the agency that carried out the adjustment of the control network. This covariance matrix contains all the necessary information about the random uncertainties in the adjusted control network. The appropriate part of the complete network's covariance matrix should then be used in the adjustment of the coastline survey in the proper manner, i.e., to weight properly the positions of the applicable control points in the new adjustment; see for instance (Vaníček and Lugoe 1986).

When the new survey of coastline points is adjusted, the covariance matrix of the adjusted coastline positions is obtained as a by-product in the adjustment. This covariance matrix again contains all the information about the random uncertainties in the adjusted positions and can be easily converted into absolute confidence regions (Mikhail, 1976; §11.5.2). These ellipses portray the random uncertainties in the new positions in the context of the control network. To obtain (adjusted) positions without consideration of the random uncertainty is unacceptable in geodesy. The rationale for this requirement is easily understood: the uncertainty represents a rudimentary quality control. It is not difficult to realize that a position with an uncertainty of, say, 10 km may not be acceptable, while an uncertainty of a few centimetres would indicate a very accurately determined position. Naturally, the ultimate use of the position dictates the required accuracy.

In many applications it is more important to know the relative uncertainties of one position with respect to other positions, than to know the absolute uncertainties. Relative uncertainties of random origin are also readily obtained from the covariance matrix of the adjusted positions. These uncertainties closely reflect the random errors in the observations. Relative systematic distortions can be generated from the mathematical description of these distortions.

A few words about vertical measurements and the necessary vertical control are also in order. "Geodetic vertical control" consists of a network of levelling benchmarks the (orthometric) heights of which, as already indicated in Section 2.2, and are referred to the Geoid via the local mean sea levels. As with the horizontal control, there are random and systematic errors associated with vertical control points. As with horizontal control, these errors should be propagated into the newly determined heights of coastal points.

The location of the low-water line will require careful tide measurements in areas where the coast is gently sloping, because any error in vertical measurement may result in a considerable horizontal displacement. It is extremely important to obtain the exact height above low water datum of all off-lying rocks, sandbars and other features. At the same time the tidal range must be precisely determined in order that it will be known if these features are above or below high water. Whether or not a feature is a low-tide elevation (see Article 13) or a feature permanently above high water may assume considerable importance. It is thus necessary to pay maximum attention not only to the trend of the tide, but also to the possible influence of meteorological factors on sea level. Such influence is greater in shallow waters and in coastal areas that feature low gradients.

Determining the coastline becomes more difficult in zones having large differences in tide and where ice and storm surges may exist.

By the end of the survey the coastline will be represented as a continuous polygon line with straight legs of varying length depending on the configuration of the coast.

Photogrammetric surveys may be used in addition to the geodetic methods to define precisely the entire extent of the low-water line, thereby providing details between the surveyed points.

The above accurate geodetic-topographical method may not always be possible, in view of natural conditions in some regions of the world. Low lying coastlines that are subject to intensive erosive processes, which feature large tidal ranges, and which are bordered by extensive soft mud banks may make classical survey methods difficult. In such cases, aerial photographs and satellite images may be utilized at low-water, and bathymetric surveys at high-water, in order to establish the low-water line.

There may be a requirement to produce a special report, including the working documents and calculations, to substantiate the results of the survey measurements and consequent delineation of the coastline.

2.6.3 Satellite Positioning

As stated above, geodetic coordinates can be established by triangulation, trilateration, traverses or by satellite observations (Doppler, GPS or GLONASS). In practice, just as traverses have superseded triangulation with the advent of tellurometers and geodimeters, now satellite geodesy is superseding traverses, with the introduction of satellite geodetic receivers. Satellite positioning can be done in one of the following two modes: point positioning, or relative (differential) positioning with respect to one or more nearby points whose positions are already known. The latter mode is inherently more precise by at least one order of magnitude; see for instance (Seeber, 1993 and 2003; §4). The actual accuracy depends on the instrumentation, duration and care devoted to the observations, the kind of GPS software, and the way in which it is used. On these matters the interested reader would be well advised to consult one of the existing texts such as (Wells *et al.,* 1987; Rizos, 1990; Hofmann-Wellenhof et al. 2001; Seeber, 1993 and 2003; Leick, 2004).

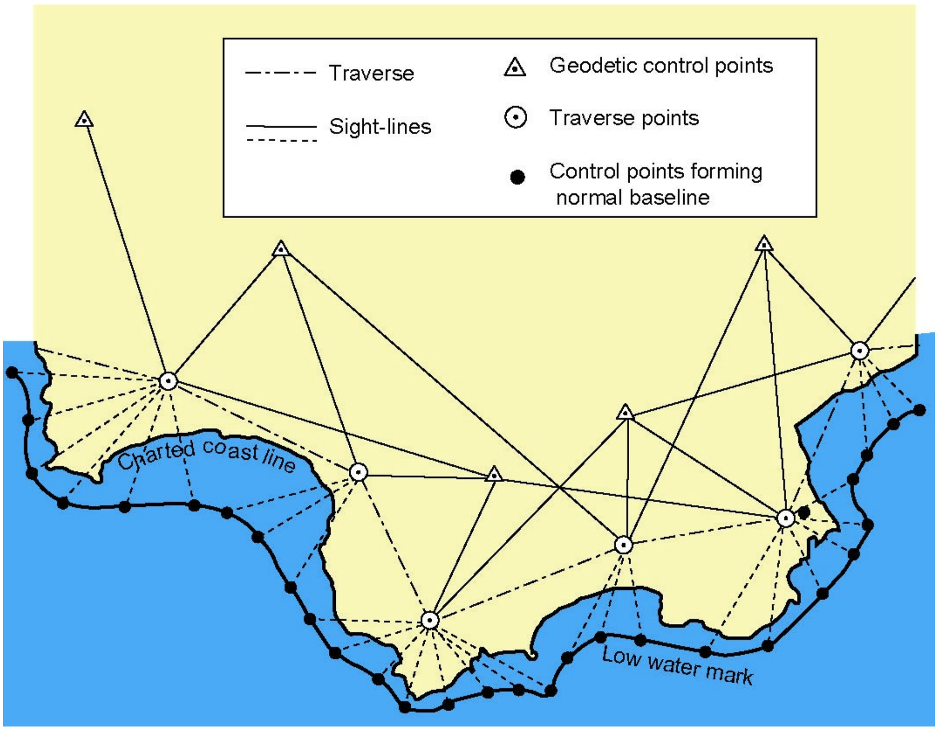


Figure 2.11 - Determination of baseline control points (From Thamsborg, 1983)

Both modes of positioning by satellite yield three-dimensional positions. Positions or position differences are usually expressed in three-dimensional geocentric Cartesian coordinates or coordinate differences, which can subsequently be transformed into geodetic latitude ϕ, longitude

λ and height h, or their differences (Vaníček and Krakiwsky, 1986; §15.4). Because one starts with geocentric Cartesian coordinates, these "curvilinear coordinates" are also referred to a geocentric horizontal datum as discussed in Section 2.4.3. For example, curvilinear coordinates or coordinate differences determined by GPS are referred to WGS 84. It is important to realize that heights or height differences determined in this way are of the geodetic variety and cannot be used in lieu of the usual heights above the sea level, e.g., in lieu of the orthometric heights. As explained elsewhere, the Geoidal height or the Geoidal height difference, referred to the appropriate geocentric horizontal datum, must be known to carry out the transformation.

To transform the horizontal coordinates or coordinate differences from the geocentric datum to the local datum, one must use the same procedure as outlined Section 2.4.4. When determining the transformation parameters, one must take into account the fact that positions determined by satellite do contain errors, which result in positional uncertainties much like those resulting from terrestrial measurements.

As the distance increases between an off-shore isolated topographical position and the mainland where the local datum is more accurately defined, the possibility of erroneous positioning increases and this can produce an inaccurate maritime boundary delimitation. Geodetic satellite receivers allow such isolated positions to be coordinated accurately relative to the mainland, eliminating many of the error sources previously connected with astro-geodetic measurements.

2.7 DETERMINATION OF AREAS

In the application of the Law of the Sea, the areas of closed polygons limited by meridian lines, parallels, great circles or geodesics are of primary interest. For very small areas, straight lines in the projection plane can usually serve as an acceptable approximation, and the area they enclose can be determined by the coordinate formula (e.g. (Richardus 1984, §2)). On the sphere, the area of any closed polygon can be precisely determined by considering the spherical excess, provided that the angles between the polygon sides are known.

Although the reference surface for applying the LOS is an ellipsoid, the spherical approximation of the area will be sufficient for small closed polygons. Then the radius of the sphere corresponding to the so-called Gaussian curvature should be chosen. For explicit formulas we refer to (Kimerling 1984). (However, as angles are not measured in modern space methods, these quantities must first be determined from the coordinates of the polygon points.)

Another approximate method is to perform the area calculation by the coordinate method in an area preserving (equality) projection. The disadvantage is that geodesics are not straight lines in such a projection plane, which inevitably leads to approximation uncertainties that increase with the size of the area. As an example, (Gillissen 1994) used this method with Abel's equality projection. Alternatively, if the polygon lines are loxodromes, the polygon is composed of straight lines in Mercator's projection; as this projection is not area preserving, the calculated area will again be in error.

(Sjöberg, in press) extended Kimerling's method to a series solution to desired accuracy for a geodetic polygon of any size. Alternatively, the series derived by (Danielsen 1989) for the area under the geodesic could be useful. (Baeschlin 1948, p. 203) presented a closed but approximate equation for the area of an ellipsoidal triangle. Also, for any closed polygon on the ellipsoid, limited by meridian lines and parallels, the area can be exactly determined by adding closed expressions for the areas of blocks; see e.g. (Baeschlin 1948, p. 59). Finally Sjöberg (2006) presents practical formulae for numerical computations of areas, arc lengths, etc., related to geodesics.

Table 2.1 - LIST OF ELLIPSOIDS

ELLIPSOIDS	SEMI MAJOR AXIS	1/FLATTENING
AIG 1975	6378140.	298.257
AIRY 1830 HOTINE *(see AIRY 1848)*		
AIRY 1848	6377563.3963	299.3249646
AIRY MODIFIED	6377340.1891	299.3249646
AIRY-US	6377542.178	299.325
APL MK 4.5	6378137.	298.25
APL NAVIGATION	6378144.	298.23
APL 5.0	6378140.	298.26
APL-OMA	6378165.953	298.3
AUSTRALIA 165	6378165.	298.3
AUSTRALIAN NATIONAL	6378160.	298.25
BESSEL 1841	6377397.155	299.1528128
BESSEL FM 1841	6377397.155	299.152813
BESSEL NORWAY	6377492.018	299.1528
BESSEL US	6377397.2	299.15
BESSEL 1841 PORTUGAL	6377397.155	299.1528
CLARKE 1858	6378293.645	294.26
CLARKE 1866	6378206.4	294.9786982
CLARKE 1866 MICHIGAN	6378450.047	294.978698
CLARKE 1880 ENGLAND	6378249.1453	293.465
CLARKE 1880 IGN	6378249.2	293.466021
CLARKE 1880 MODIFIED	6378249.1388	293.466308
CLARKE 1880 PALESTINE	6378300.7893	293.466307
DANISH	6377104.43	300.
DENMARK	6377019.26	300.
DELAMBRE 1810-CARTE DE France	6376985.	308.64
DGFI 1986	6378144.11	298.257
DGFI 1987	6378136.	298.257
DU PLESSIS"RECONSTITUE"AMS 1944	6379523.994	
EVEREST 1830	6377276.3452	300.8017
EVEREST BARI	6377301.2435	300.801725
EVEREST BORNEO	6377298.556	300.8017
FISCHER 1955	6378155.	298.3
GERMAIN	6378284.	294.28
GEM-NASA	6378155.	298.255
GHANA NATIONAL	6378295.	296.004037
GSFC 145	6378145.	298.255
GSFC 138	6378138.	298.255
HAYFORD 1909 *(see HAYFORD (INTERNATIONAL))*		
HAYFORD (INTERNATIONAL)	6378388.	297.
HEISKANEN 1929	6378400.	298.2
HELMERT 1907 (1906)	6378200.	298.3

ELLIPSOIDS	SEMI MAJOR AXIS	1/FLATTENING
HOLLANDAIS	6376850.	309.6
HOUGH	6378270.	297.
IAG GRS 1967	6378160.	298.247167
IAG GRS 1980	6378137.	298.257222
JEFFREYS 1948	6378099.	297.1
KRASSOWSKY URSS	6378245.	298.3
MALAYAN (EVEREST MODIFIED)	6377304.063	300.8017
MERCURY 1960	6378166.	298.3
MERCURY MODIFIED 1968	6378150.	298.3
NASA	6378148.	298.3
NASA-GEN9	6378140.	298.255
NASA-GEM10B	6378138.	298.257
PLESSIS	6376523.	308.64
POIDS-MESURES 1799	6375739.	334.29
SAO SE-1	6378165.	298.25
SAO SE-3	6378140.	298.256
SOUTH AMERICAN 1969	6378160.	298.25
STRUVE ESPAGNE	6378298.3	294.729991
SVANBERG SUEDE	6376797.	304.2506
UAI 1964	6378160.	298.25
UTEX	6378137.	298.255
WALBECK URSS	6376895.	302.782157
WGS 1960	6378165.	298.3
WGS 1966	6378145.	298.25
WGS 1972	6378135.	298.26
WGS 1984	6378137.	298.257223563

Note: The list of ellipsoids has been compiled by the IHB from different sources and is neither exhaustive nor authoritative.

TABLE 2.2 - TRANSFORMATIONS BETWEEN LOCAL DATUMS AND WGS 84 DETERMINED BY DMA (NOW NGA)

Local Geodetic Systems (Datums)	Associated Reference Ellipsoid
Adindan	Clarke 1880
Afgooye	Krassovsky
Ain el Abd 1970	International
Anna 1 Astro 1865	Australian National
Arc 1950	Clarke 1880
Arc 1960	Clarke 1880
Ascension Island 1958	International
Astro Beacon "E"	International
Astro B4 Soro Atoll	International
Astro DOS 71/4	International
Astronomic Station 1952	International
Australian Geodetic 1966	Australian National

Local Geodetic Systems (Datums)	Associated Reference Ellipsoid
Australian Geodetic 1984	Australian National
Bellevue (IGN)	International
Bermuda 1957	Clarke 1866
Bogota Observatory	International
Campo Inchauspe	International
Canton Astro 1966	International
Cape	Clarke 1880
Cape Canaveral	Clarke 1866
Carthage	Clarke 1880
Chatham 1971	International
Chua Astro	International
Corrego Alegre	International
Djakarta	Bessel 1841
DOS 1968	International
Easter Island 1967	International
European 1950	International
European 1979	International
Gandajika Base	International
Geodetic Datum 1949	International
Guam 1963	Clarke 1866
GUX 1 Astro	International
Hjorsey 1955	International
Hong Kong 1963	International
Indian	Everest
Ireland 1965	Modified Airy
ISTS 073 Astro 1969	International
Johnston Island 1961	International
Kandawala	Everest
Kerguelen Island	International
Kertau 1948	Modified Everest
L.C. 5 Astro	Clarke 1866
Liberia 1964	Clarke 1880
Luzon	Clarke 1886
Mahe 1971	Clarke 1880
Marco Astro	International
Massawa	Bessel 1941
Merchich	Clarke 1880
Midway Astro 1961	International
Minna	Clarke 1880
Nahrwan	Clarke 1880
Naparima, BWI	International
North American 1927	Clarke 1866
North American 1983	GRS 80*
Observatorio 1966	International
Old Egyptian	Helmert 1906
Old Hawaiian	Clarke 1866

Local Geodetic Systems (Datums)	Associated Reference Ellipsoid
Oman	Clarke 1880
Ordnance Surveyof Great Britain 1936	Airy
Pico de las Nieves	International
Pitcairn Astro 1967	International
Provisional South Chilean 1963**	International
Provisional South American 1956	International
Puerto Rico	Clarke 1866
Qatar National	International
Qornoq	International
Reunion	International
Rome 1940	International
Santo (DOS)	International
Sao Braz	International
Sapper Hill 1943	International
Schwarzeck	Bessel 1841
South American 1969	South American 1969
South Asia	Modified Fisher 1960
Southeast Base	International
Southeast Base	International
Timbalai 1948	Everest
Tokyo	Bassel 1841
Tristan Astro 1968	International
Viti Levu 1916	Clarke 1880
Wake-Eniwetok 1960	Hough
Zanderij	International

* Geodetic Reference System 1980
** Also known as Hito XVIII 1963

(From NIMA TR 8350.2, 3rd Edition, 1997)
(Provided through the courtesy of the US National Imagery and Mapping Agency)

CHAPTER 3 - CHARTS

TABLE OF CONTENTS

3.1 INTRODUCTION

A nautical chart is a graphical representation of a maritime area and adjacent coastal regions. It shows depths of water and heights of land, natural features of the seabed, details of the coastline, navigational hazards, locations of natural and man-made aids to navigation, information on tides and currents, local details of the Earth's magnetic field, and man-made structures such as harbours and bridges. It is an indispensable tool of navigation.
(http://www.yourencyclopedia.net/Nautical_chart)

Nautical charts are based on hydrographic surveys. Hydrographic surveying is a slow, time-consuming task. Hydrographic data for some areas may therefore be dated and not meet modern standards. Nautical charts may be in paper or electronic format.

The LOS Convention specifies that the baselines, the limits from which other limits are derived, and in general, the lines of delimitation between States, shall be shown on charts of a scale or scales adequate for ascertaining their position. The coastal State shall give due publicity to such charts or lists of geographical coordinates and shall deposit a copy of each such chart or list with the Secretary-General of the United Nations (Articles 16, 47, 53, 75, 84).

3.2 NAUTICAL CHARTS

The chart is a useful tool to use in order to study or display the inner and outer limits of national jurisdiction, or the boundary between national jurisdictions of one or more States. The chart should be recognized by the coastal states concerned and it should represent, in sufficient detail, the configuration of the coast and the morphology of the coastal zone including the sea floor.

In almost all countries at present, the nautical chart is the only type of chart (or map) which comes close to meeting the needs of legal bodies and cartographers responsible for carrying out the task of boundary delimitation. It must be borne in mind that the nautical chart was specifically designed for the safe passage of vessels and it is incidental that it may contain some of the basic elements which are necessary to satisfy the above mentioned purposes, e.g.:

- a. The coastline, with a reasonable part of the hinterland;
- b. The seaward area over which the delimitation is to be made.

It should be borne in mind that in order to represent the curved Earth surface on a plane it is necessary to use a projection. The use of a projection will introduce distortions which must be accounted for in its use for any delimitation.

The following properties must be considered when using a chart:

- a. Chart projection;
- b. Chart scale;
- c. Horizontal datum;
- d. Vertical datum.

These factors have such an important influence on the practical definition of maritime boundaries that consideration of them is of fundamental importance, especially when a boundary-determining operation involves the use of charts with dissimilar characteristics and datums. The charts to be used should reflect the present situation as accurately as possible and they should be based on the most recent surveys. There are two different types of nautical charts: paper and electronic. Electronic charts are further divided into Raster Nautical Charts (RNC) and Electronic Navigational Charts (ENC).

3.2.1 Paper Charts

The Arabs were probably the first to employ paper or animal skin to draw nautical charts (Piri Reis was one of the first Ottoman Turkish mapmakers). The technique has been improved over the centuries but the material used has been the same: a sheet of paper. Nowadays paper charts are printed by offset machines or by plotters and are still widely used by mariners.

3.2.2 Electronic Charts

Electronic charts can be divided into two general categories vector and raster:

3.2.2.1 Raster Charts

Raster data formats are known as geo-referenced bitmaps, i.e. they consist of images that are referred to specific locations on the surface of the Earth. A bitmap is a generic term for a computer image made up of a rectangular grid of very small (254 per inch is one standard) coloured squares or pixels. These bitmaps are usually generated by taking the original fair sheets or charts themselves and scanning them to create a digital image of the chart. Once this image has been acquired, a geo-reference is applied. However, the system has no knowledge of the details (such as the coast line) in the raster images it displays.

3.2.2.2 Vector Charts

There are several vector file formats, each of which stores information in its own way, however they all use the object-oriented concept. Objects may be points, lines or polygons. Each object will have some meta-data associated with it such that it can be considered ‘intelligent data’. For example the computer will know that a particular line is the 50m contour. Similar information can be included on discrete layers and most vector charting systems allow the navigator to deactivate or hide certain layers of information, down to a basic level. In some cases, objects are hidden and shown automatically at different zoom levels based on settings stored in the chart file.

Another key function of vector data is that most of these vector objects have some sort of navigationally useful information associated with them. Since they are discrete objects, they can be addressed as such from a system point of view. This means that a system can be designed to allow the navigator to manually query different objects for their properties, or to have the system do so automatically. For example, a system can be set up so that whenever the navigator clicks on a light, its characteristics are displayed onscreen. At a higher level of automation, a system can be designed to look ahead of the vessel a certain distance (or time) for any sounding, depth contour or land region which interferes with the vessel’s safe navigation.

3.2.3 Electronic Navigational Chart (ENC)

An Electronic Navigational Chart (ENC) consists of a database that has been standardized as to content, structure and format, and which has been issued for use with an Electronic Chart Display and Information System (ECDIS – see Figure 3.1). ENCs are prepared and issued by or on the authority of Government-authorized Hydrographic Offices, or by other relevant government institutions. An ENC is an official chart and should not be confused with Electronic Charts (EC) sold by commercial companies. The ENC contains all the chart information necessary for safe navigation, and may contain supplementary information in addition to that contained in the paper chart (e.g., sailing directions, which may be considered necessary for safe navigation (See Section 2.2 of the International Maritime Organization (IMO) Performance Standards for ECDIS:).

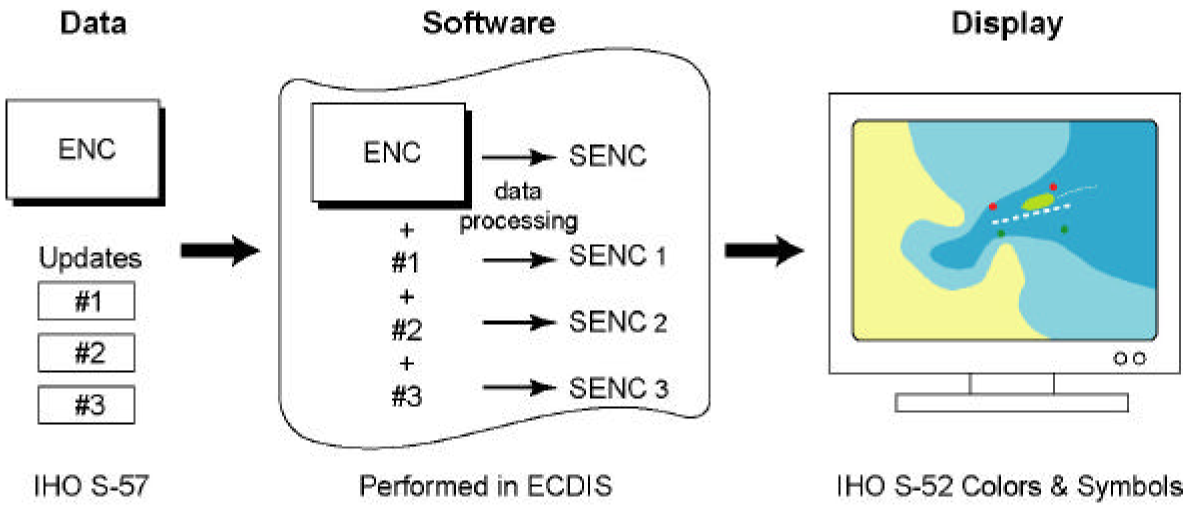


Figure 3.1 - ECDIS components

3.2.4 Digital Nautical Chart (DNC)

The Digital Nautical Chart is produced by the United States National Geospatial-Intelligence Agency (NGA). It is an unclassified, vector-based, digital database containing significant maritime features that are essential for safe navigation. The DNC is being produced to meet the worldwide navigation requirements of the U.S. Navy and the U.S. Coast Guard. With contents drawn from a portfolio of approximately 5,000 nautical charts, it will ultimately support global marine navigation between 84°N and 81°S, and it will operate in a variety of Geographic Information System applications.

3.3. HISTORICAL DATA

Historical survey and cartographic data may be needed to help prove or disprove the existence of features which could justify different or particular interpretations of the articles of the LOS Convention. Most charts are compiled from the results of hydrographic surveys which are very time consuming operations, even with modern equipment. Ocean surveys have been undertaken by a limited number of maritime States. Consequently, large areas of the world's continental shelves have never been properly surveyed, and significant areas of coastal waters have not been surveyed in the detail required for today's shipping or for LOS boundary delimitation.

The significance of this variable quality of charts in maritime boundary delimitation is that:

a. Geographical positions may be based upon inaccurate, imperfect or inadequate observations;

b. In areas where the low-water line is composed of soft materials like mud or sand, the details are likely to have changed since the surveys were undertaken, particularly in areas of strong currents or tidal streams, or along coasts that are subject to major storms.

c. If the chart has been based on the original printing plates it may not be clear from the symbols used at that time which contour line or lines represent the low-water line.

The publication date of a chart is not an indication of the age of the source material from which it is compiled. A chart with an early publication date may have had modern work added to it, whilst a recently published chart, in a modern format, may have been compiled from old surveys. An indication of the true situation may be found on the chart, for instance in the title block of an older chart. Recently produced charts may include "source" and "reliability" diagrams, which provide details of the origin of the surveys, the spacing of the sounding lines, and the methods used in the surveys. These allow the user to evaluate the quality of the chart (see Section 3.4).

Raster Nautical Charts (RNCs) are images of paper charts, and therefore the above considerations are valid for them as well. ENCs are a new concept based on digital data, and their accuracy can be much better than paper or raster charts.

3.3.1 Examples of Old and New Paper Chart Styles

Figures 3.2 and 3.3 show a portion of French Charts 5420 and 7033 respectively.

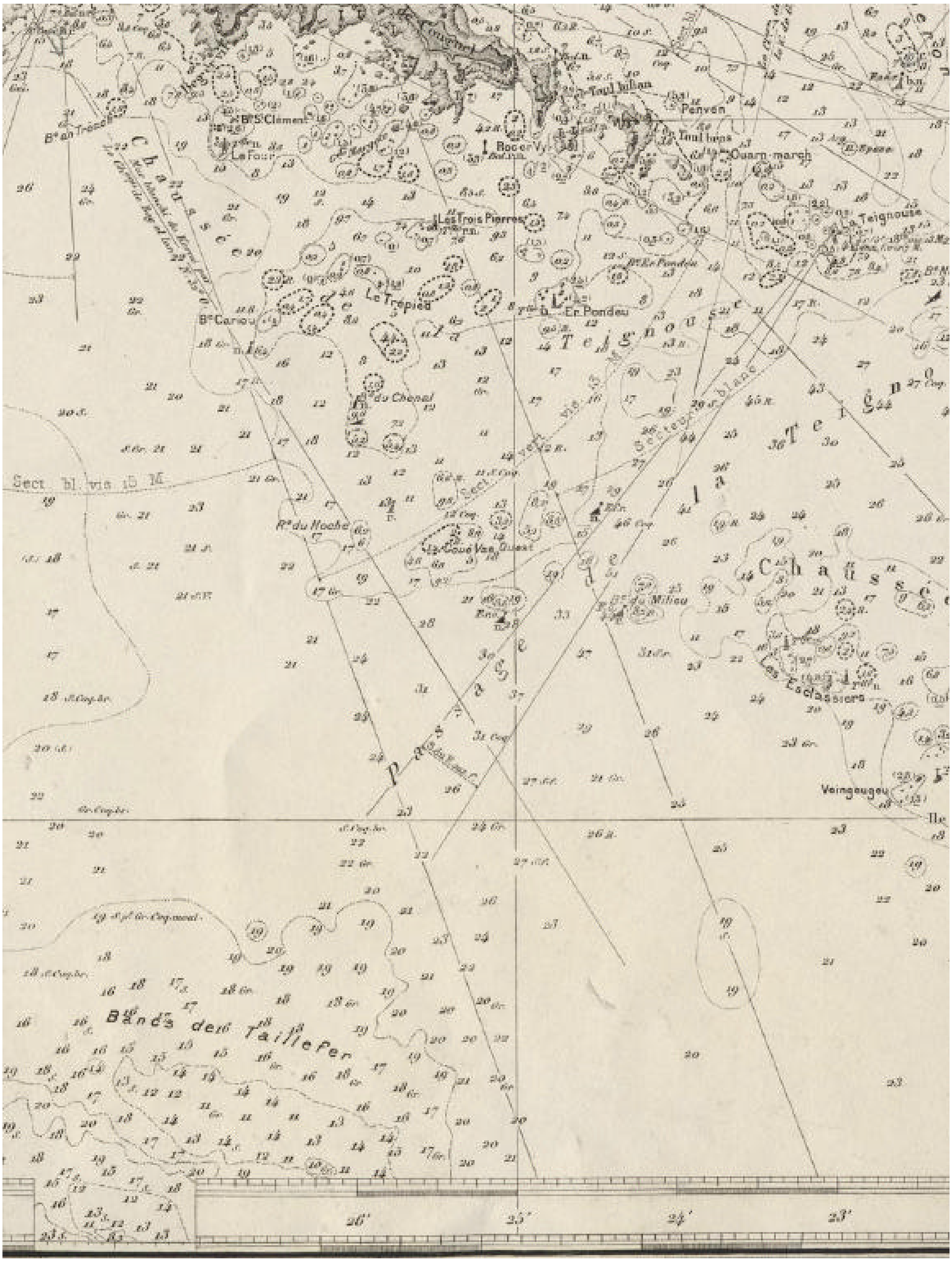


Figure 3.2 - Example of old chart style
(Courtesy of Service Hydrographique et Océanographique de la Marine (SHOM))

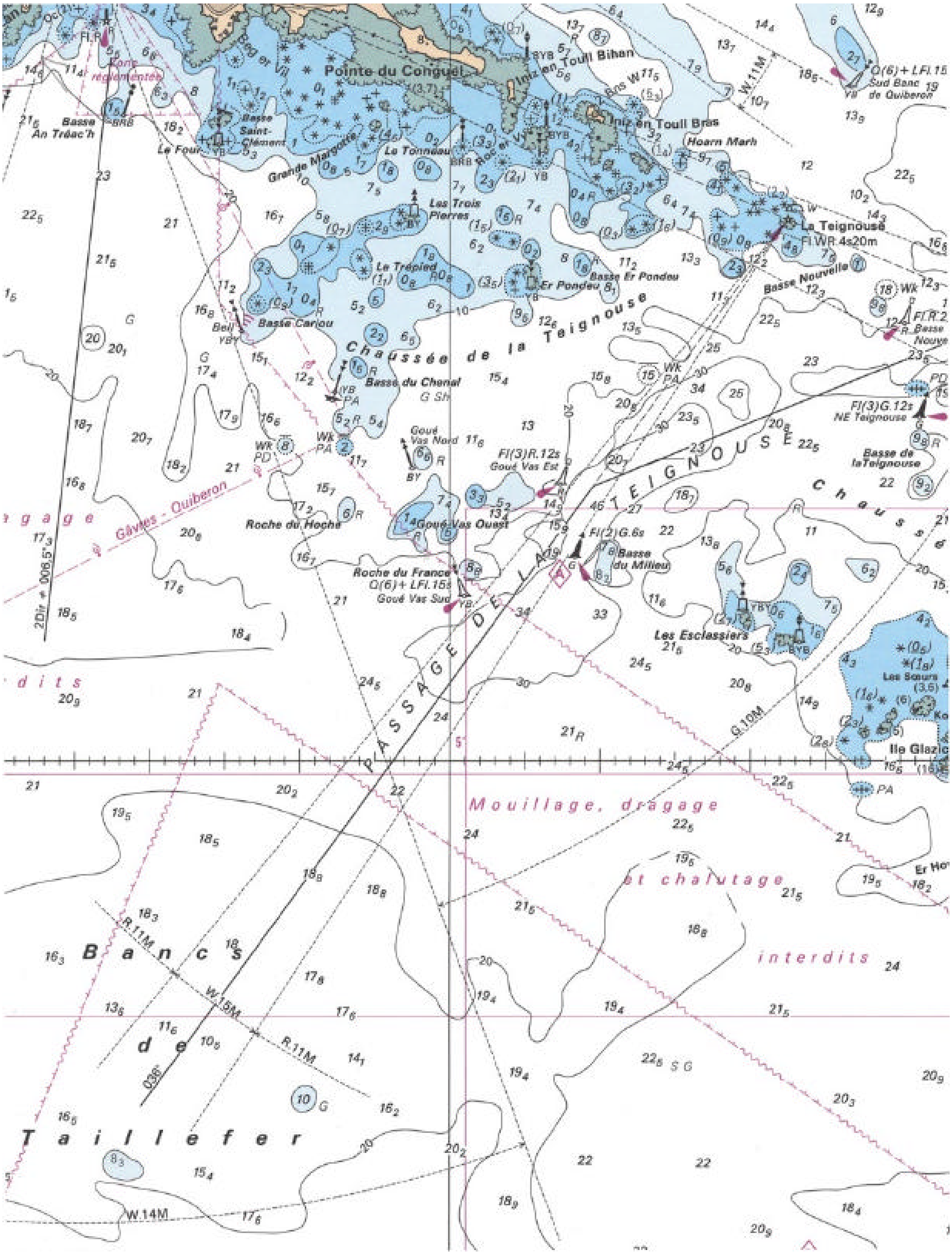


Figure 3.3 - Example of new chart style
(Courtesy of Service Hydrographique et Océanographique de la Marine (SHOM))

3.4 RELIABILITY

3.4.1 Source Diagrams

Most charts include a ‘Source Data Diagram’, see Figure 3.4, which shows the areas and dates of the surveys from which the chart has been compiled. This will be indicative of the likely quality of the data, and of any inaccuracies that might be anticipated.

3.4.2 Reliability Diagrams

Some charts include reliability rather than source diagrams. Reliability diagrams give an assessment of accuracy and advise on preferred areas for navigation See Figure 3.5.

3.4.3 Dual-purpose Diagrams

Source and reliability diagrams may include additional information, usually printed in a different colour, e.g. magenta, where it is not possible or inappropriate to show this information elsewhere.

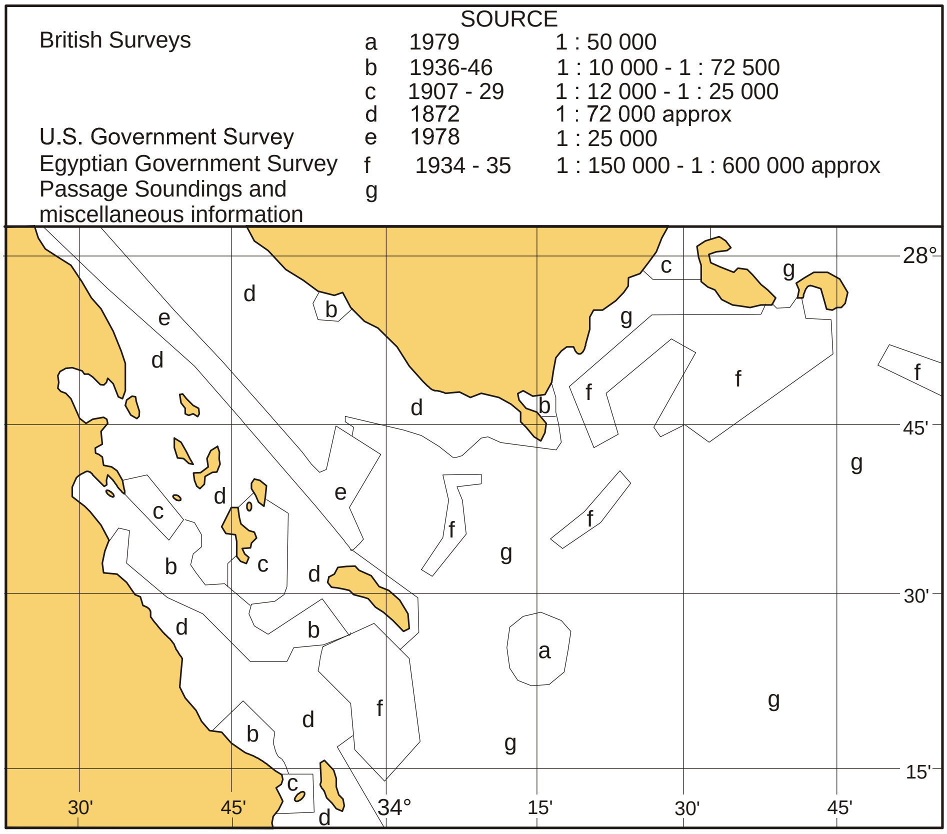
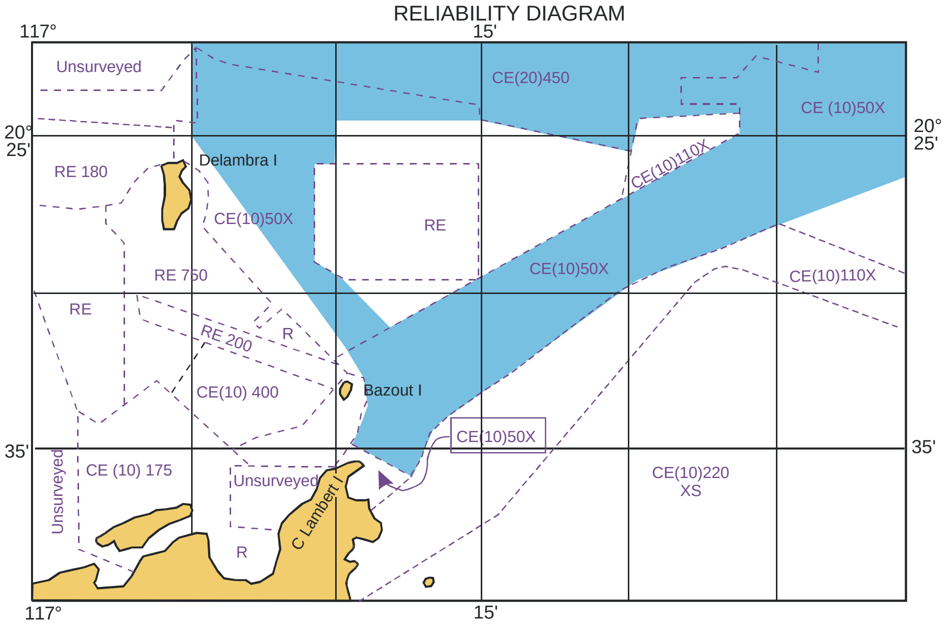


Figure 3.4 - Source Diagram (From Chart Specifications of the IHO, M-4)



KEY TO SYMBOLS

R Reconnaissance or incomplete survey	400 Distance apart of main lines of soundings in metres
C Controlled survey	X Shoals have been examined
L Sounded by lead line	▭ Areas preferred for navigation having regard to chated depths
E Sounded by Echo Sounder	S Sonar swept
(6) Accuracy of soundings in decimeters	

Figure 3.5 - Reliability Diagram (From Chart Specifications of the IHO, M-4)

3.4.4 Updating Charts

Charts are brought up to date in three ways. First, a new plate may be prepared from which a new chart is printed. The date of publication will indicate when the plate was made. Second, the plate may be amended - perhaps to incorporate the results of a recent survey - and from it a new edition prepared which will legally supersede all previous editions. Thirdly, smaller but nevertheless important amendments may be needed to show such things as buoy changes, location of a new wreck, changes to light characteristics, and so on. These may be promulgated by Notices to Mariners which give details that enable the user to amend his own copy of the chart. Notices to Mariners may include details of changes to features like the low-water line (and hence non negotiated territorial sea baselines). Each correction is identified by the Notice to Mariners number and date. That information should be noted at the appropriate place on each chart on which the correction is made. To ensure that the latest information is being used, it is necessary to see that the chart being referred to is the latest edition, and is fully corrected to date for Notices to Mariners.

3.5 PROJECTIONS

The surface of the Earth, being a non-planar two-dimensional surface, cannot be depicted on a two-dimensional mapping plane without distortions. These distortions may occur in the depiction of distance, angles or shapes. Map or chart projections have been developed to minimize or to eliminate as many of these distortions as possible over certain areas, and the projection used depends on the specific requirement for a chart or map. No projection can retain all the terrestrial relationships exactly and to retain one, another must be sacrificed. For most nautical charts the Mercator projection is used because it has the useful navigational feature that loxodromes or rhumb lines (see Section 3.9.3) are portrayed as straight lines, i.e. they intersect all meridians at the same angle. Unfortunately, distances and areas become greatly distorted in higher latitudes. Some projections are "conformal" in that angles are preserved and the shape of areas is retained, even if the scale must vary from one point to another.

The charts used for maritime boundary determination should preferably be on conformal projections, which provide the best available angle measurements, distances and directions (see Figure 3.6). In practice and taking into account the availability of existing charts as well as the characteristics of the area involved (location and extent), a suitable choice will normally be made from the following kinds of projections:

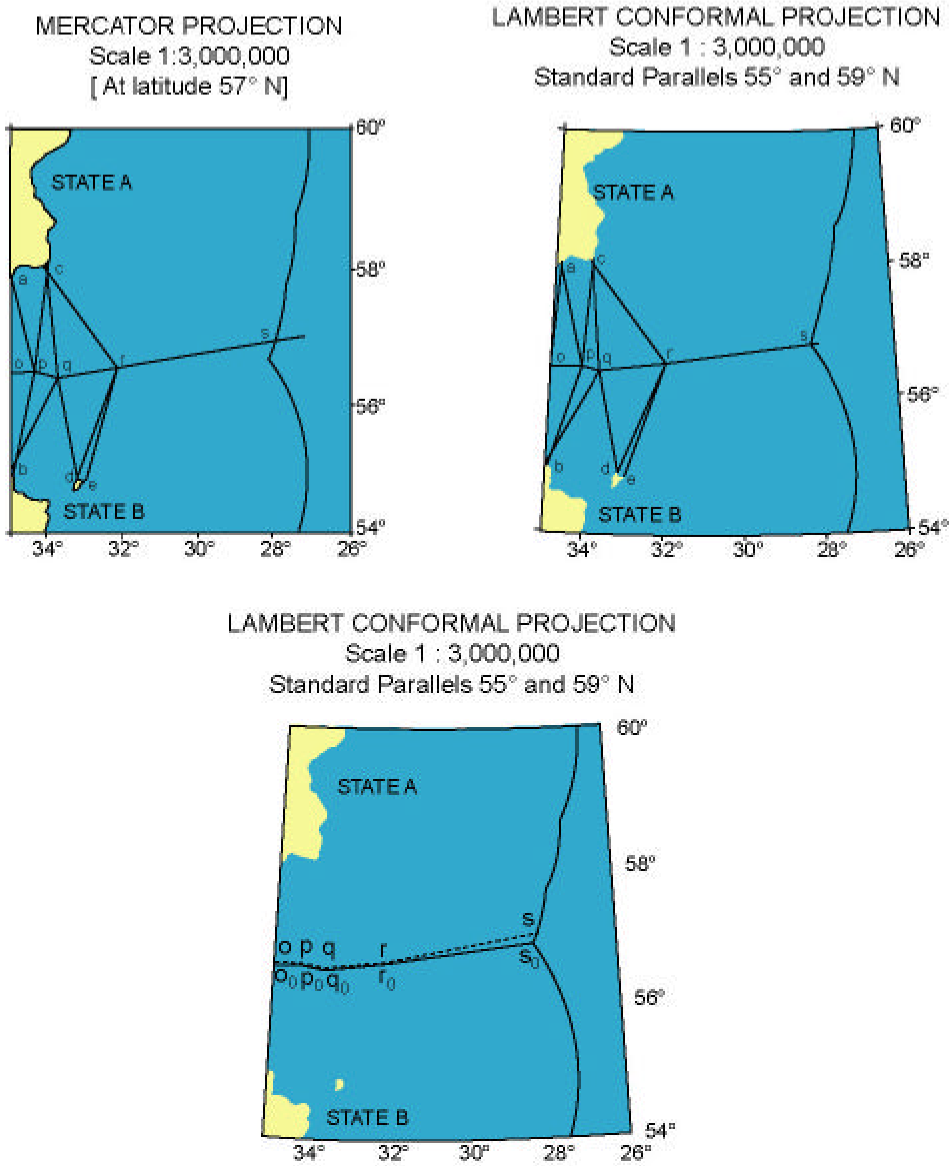
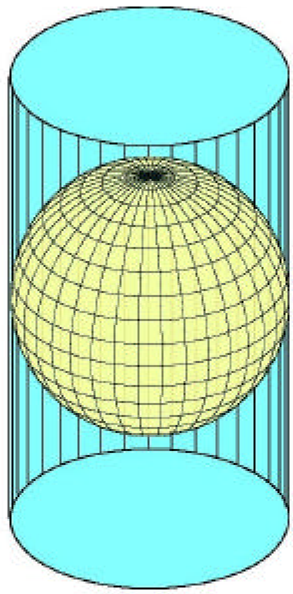


Figure 3.6 – The effects of the Mercator and Lambert Projections on the development of a hypothetical equidistant line delimitation.

3.5.1 Mercator

This projection (see Figure 3.7) has the property of depicting loxodromes as straight lines on the chart. Due to its mathematical development, distortion increases rapidly as one moves into latitudes above 15º N or S. Should charts on this projection be the only ones available in areas of higher latitudes, care should be taken as to the scale of the chart chosen and the range of the latitudes depicted, including the mid-latitude used. Distortions and errors will be increased on small-scale charts.



Cylindrical Projection surface

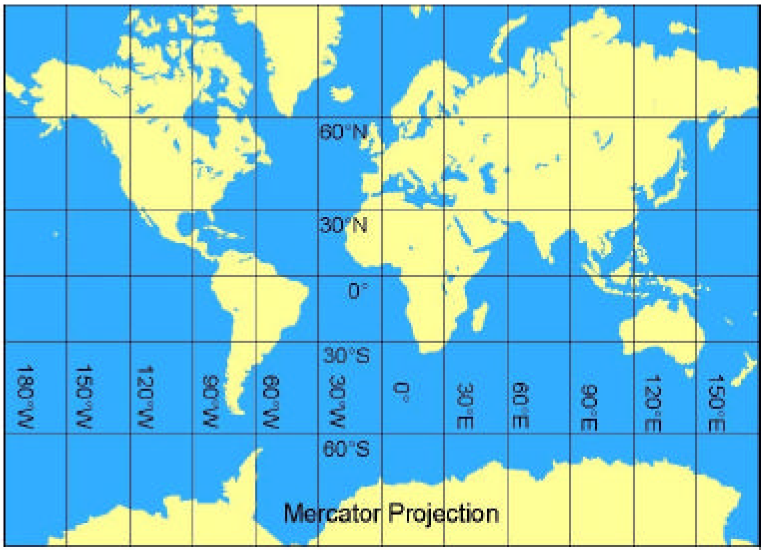
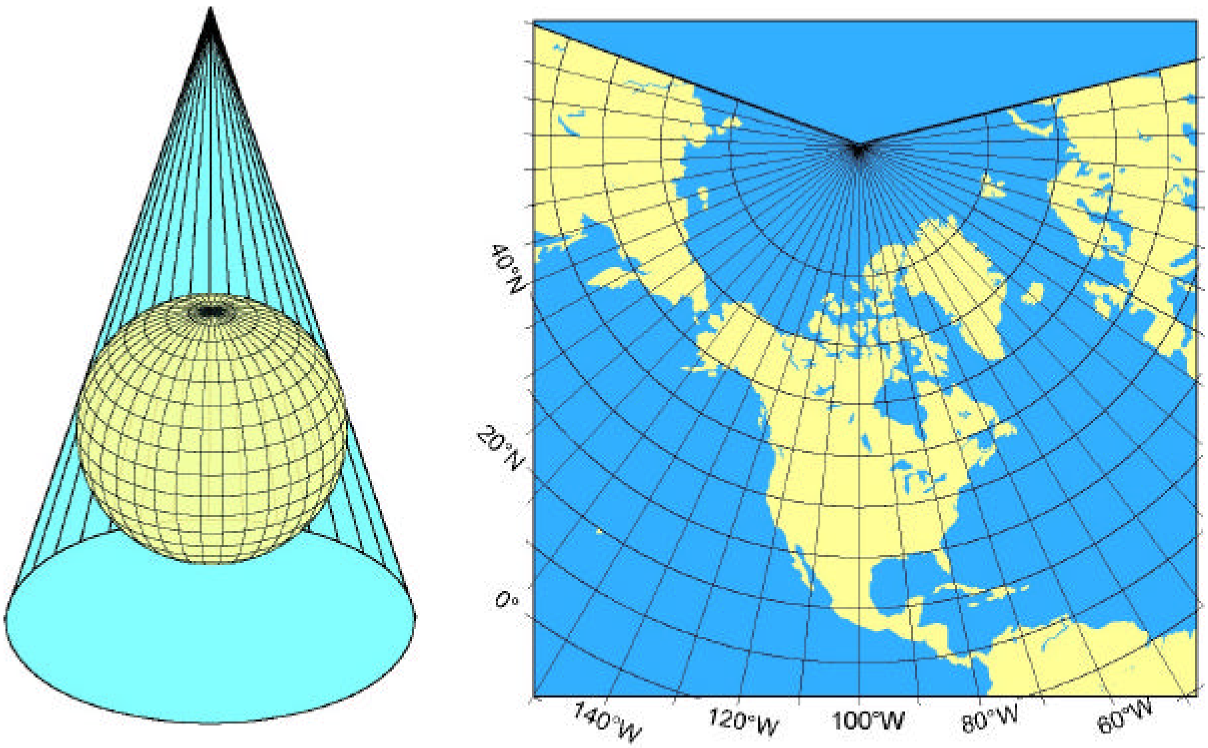


Figure 3.7 - A cylindrical projection and the Mercator Projection

3.5.2 Lambert

Lambert conformal projections (see Figure 3.8) are suitable for most delimitation tasks from 04° to 72° latitude North and South. These projections may have one or two standard 'reference' parallels. The use of two standard parallels reduces the amount of scale distortion across the map / chart. Distortions of areas close to the reference parallels are small (2% approximately), and both directions and the shape of areas are preserved. Reference parallels are generally chosen at 1/6 of the distance from the upper and lower limits of the chart in order to achieve a better distribution of the scale error in latitude. Scale is only true on the reference parallels, while in the area between the reference parallels it is compressed and beyond them it is expanded. Accuracy in distances and directions is good when measuring an area with a small extent in latitude.



Conical Projection surface
Graphical illustration

Standard parallels 25°N and 50°N, north America
Lambert projection
Appearance of grid

Figure 3.8 - The Lambert Conformal Projection

3.5.3 Transverse Mercator

This projection is a transverse cylindrical conformal projection, the cylinder being tangent along a meridian, near which is the area of minimum distortion, i.e. it is a Mercator Projection that has been rotated through 90º (see Figure 3.9).

The Universal Transverse Mercator (UTM) projection is the special adoption of the projection on a world-wide basis using standard central meridians at 6º longitude intervals. A metric rectangular grid is superimposed on each 6º-longitude band in order to allow the easy referencing of a position or area by rectangular coordinates, which are measured in metres north and south of the equator and in metres east and west of the central meridian. A false 'Easting' value of 500,000 metres is added to all Eastings so as to ensure that all values are positive. A false northing of 10,000,000 metres is added to all Northing values in southern latitudes, once again to ensure that all values are positive.

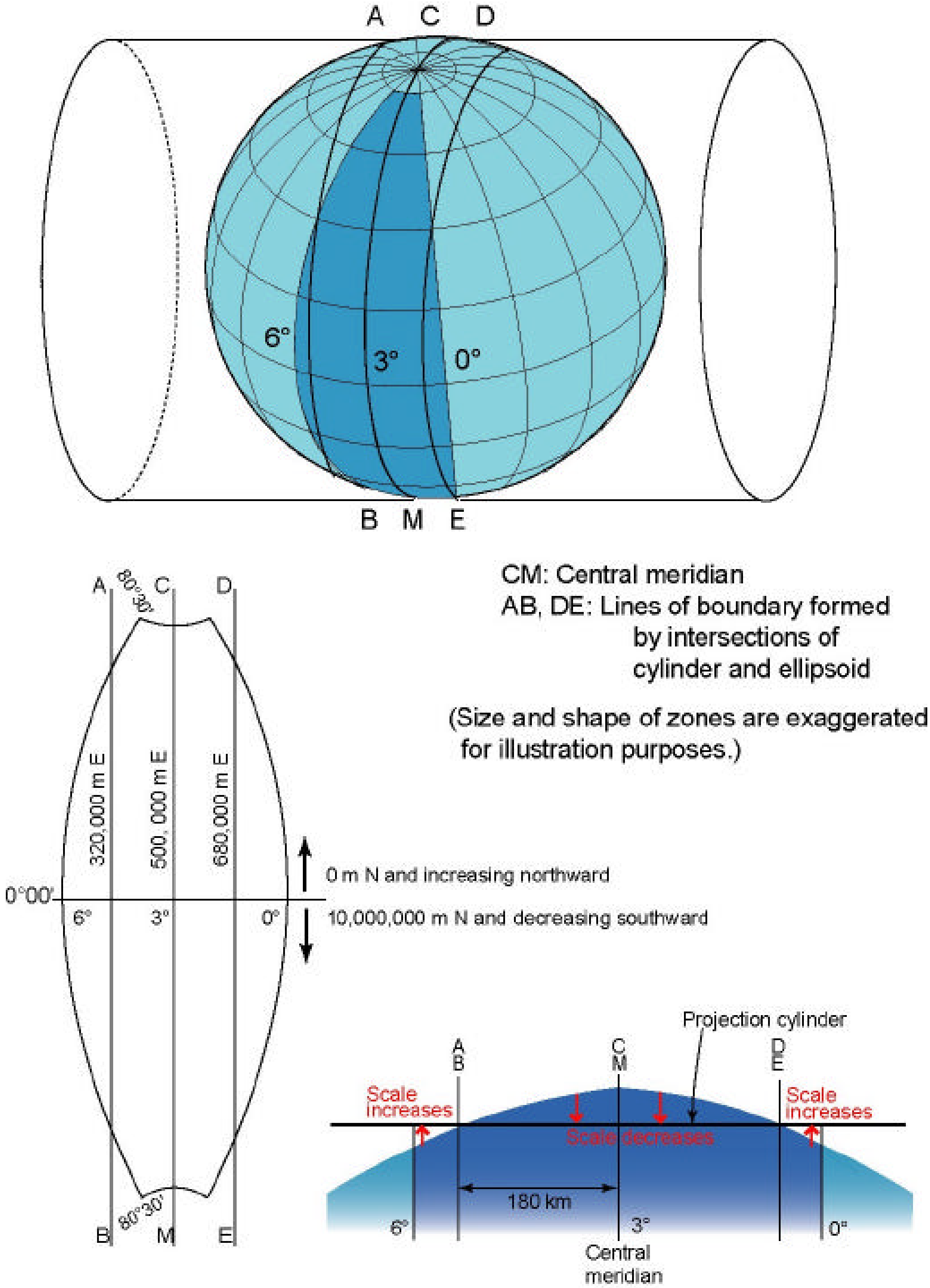


Figure 3.9 - The Transverse Mercator Projection

3.5.4 Stereographic

This belongs to the azimuthal class of projections. When centred at the poles (as is often the case), they are referred to as ‘Polar’ Stereographic Projections and are recommended for the polar regions north and south of latitude 80º (See Figure 3.10). Stereographic Projections are useful for the calculation of areas in other regions. The projection is conformal.

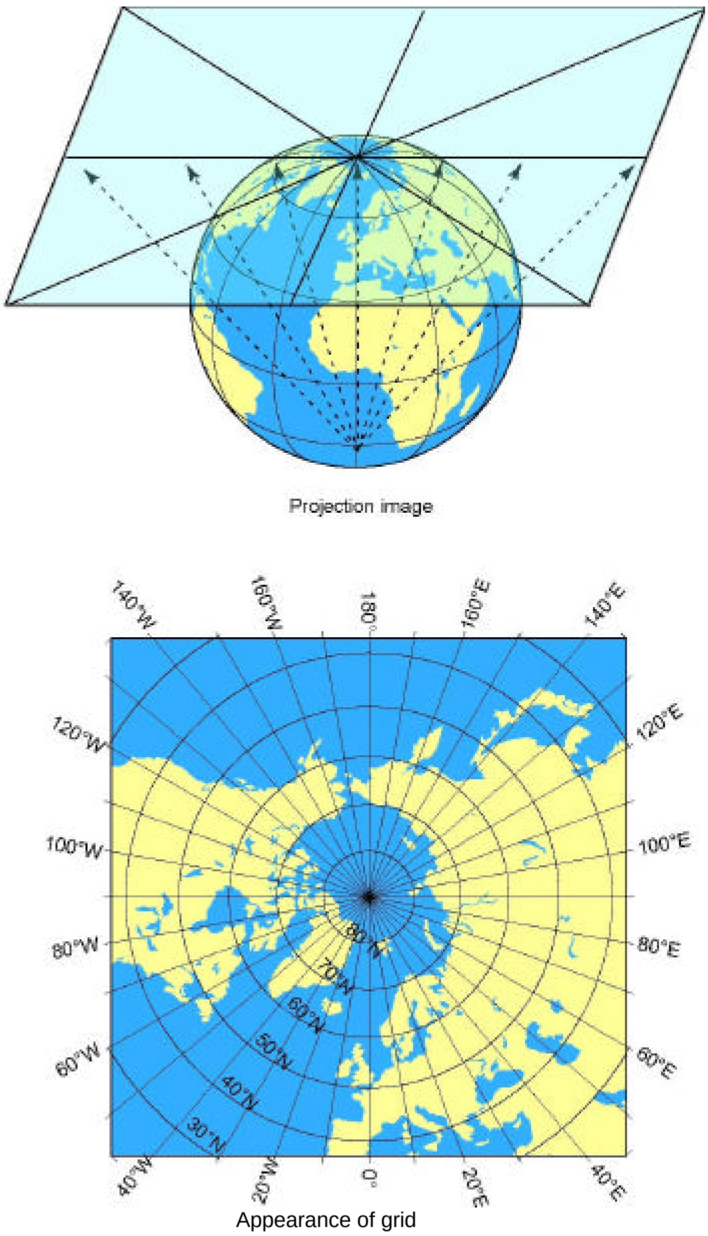


Figure 3.10 - The Stereographic Projection

3.5.5 Gnomonic Projection

The gnomonic (also called central) projection is constructed much like the azimuthal stereographic, but the projection point is located at the centre of the sphere (Figures 3.11, 3.12). Distance distortion is pronounced, other than close to the tangent point. This projection's most important property is that all geodesics, including the Equator and all meridians, are mapped as straight lines, thereby making it easy to find the shortest route between any two points (but not the direction to follow when travelling between the two points).

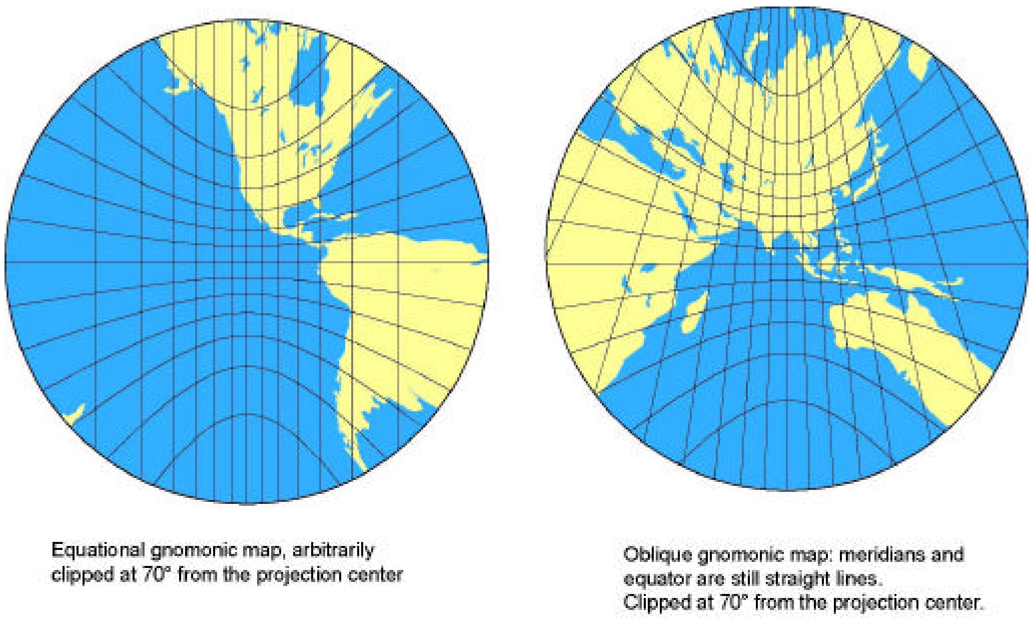


Figure 3.11 - Two different kinds of gnomonic charts

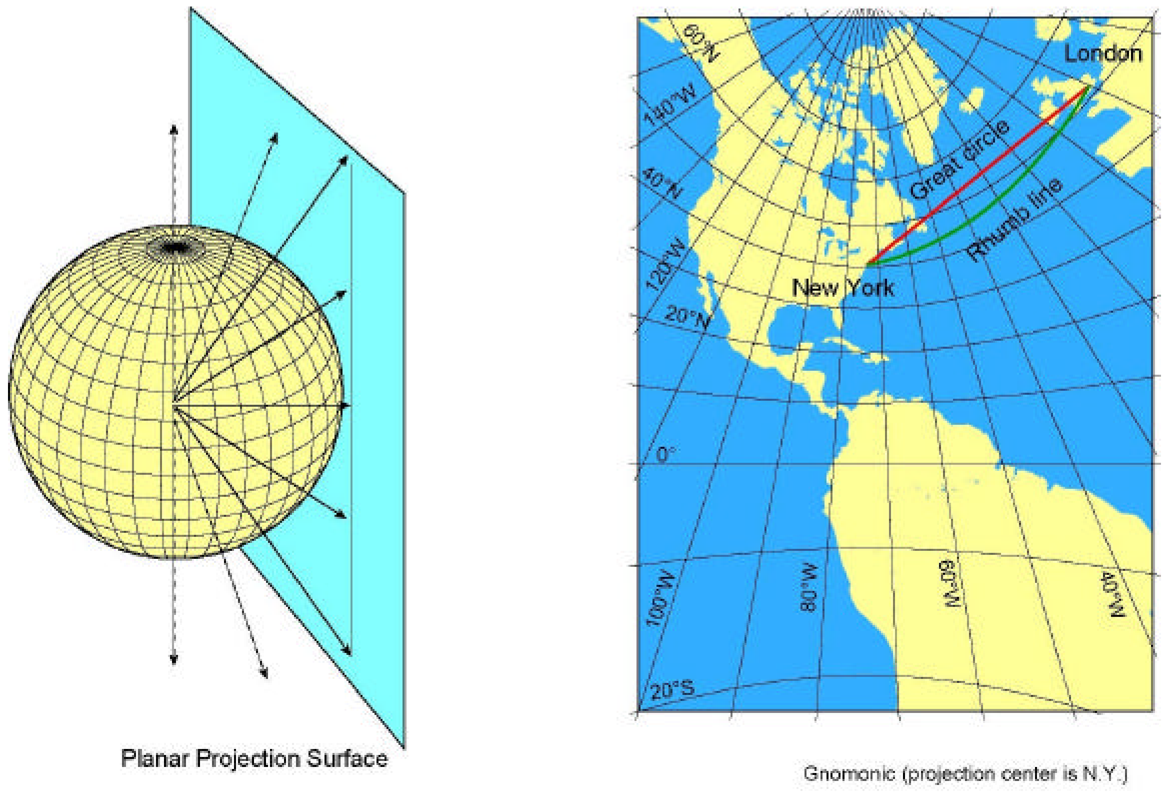


Figure 3.12 - Gnomonic projection

3.6 UNITS

3.6.1 Distance

The standard unit of distance and length measurement stipulated in the LOS Convention is the International nautical mile (M). This nautical mile, approved by IHO at the International Hydrographic Conference of 1929, has a value of 1852 metres and is equivalent to the length of a minute of arc of geographical latitude at about 44 degrees of latitude.

3.6.2 Area

The unit of area measurement is normally the square kilometre (km^2), in preference to the square nautical mile (M^2).

3.7 SCALE

The scale of a chart, termed its natural scale, is expressed either as a fraction of unity or as a ratio. The comparison is theoretically between the length of a line measured on the chart and the distance that line represents on the surface of the earth (or more accurately on the surface of the imaginary ellipsoid chosen to represent the surface of the earth). A scale of 1/500 000 or 1:500 000 indicates that a length of 1 cm on the chart represents a distance of 500 000 cms (or 5 000 metres) on the surface of the earth. Similarly a scale of 1/500 or 1:500 indicates that a length of l cm on the chart represents a distance of 500 cms (or 5 metres) on the earth's surface at the point(s) of projection. This relationship does not hold true for charts based on certain projections e.g. the Mercator projection.

Having chosen the most suitable projection, it is necessary to prepare or select a chart at the largest useful scale in relation to the area to be portrayed. The requirement in the LOS Convention is for the boundary line presentation to be done on charts of a suitable scale. This requires that the scale chosen should be large enough to cover the area concerned and to ensure the greatest accuracy possible. In accordance with the provision of Article 16, the baselines and the lines of delimitation shall be shown on charts of adequate scales for ascertaining their position, or alternatively a list of geographical coordinates of points shall be given with the geodetic datum specified. The accuracy of depiction of various lines and features on a chart is a function of the scale. A criterion in the choice of the scale is that it must provide the resolution necessary for the user to determine baselines and lines of delimitation to the same level of accuracy as originally achieved by the coastal State.

The choice of scale has a direct bearing on the accuracy with which a position can be determined on a chart by the user. The range of suitable scales will normally be from 1:100,000 to 1:1,000,000 for delimitation of the EEZ and continental shelf, while the scale for territorial boundary determinations should be of the order of 1:50,000 to 1:100,000. The plotting errors in the determination related to the various scales used are approximately as follows:

Scale	1:50,000	≈ 10 m
	1:200,000	≈ 40 m

When delimitation problems require numeric or geodetic solutions, it is necessary to extract numeric information from existing nautical charts. This is achieved by digitising the low water line and any other relevant features. In essence, the digitization process consists of a transformation from local coordinates that have been produced by a digitising apparatus (x, y in cm or inches) to geodetic latitude and longitude.

This process offers several advantages: -

a. If more recent and accurate positions have been geodetically derived, they can be used to correct the older information provided by the chart. This is achieved by using the new positions to determine the parameters of the coordinate transformation.

b. The digitization process has to be performed only once, whereas graphic solutions impose repetitive tasks.

c. The use of digital information allows for the utilization of very fast and accurate geodetic delimitation methods implemented in digital computers.

ENCs made from digital data (not from corresponding paper charts) permit a great increase in accuracy, with no plotting. Dedicated software is available that permits the use of ENCs for determining marine limits, thereby reducing the potential for error.

3.8 GRADUATION AND GRATICULE

3.8.1 Graduation

The graduation is the division and subdivision of latitude and longitude shown in the borders of a chart. All charts and most plans are graduated. A plan may be graduated on 2 sides only or it may be left ungraduated if it is of very small size or if the numbering of the graduation becomes impracticable, e.g. if successive half-minute-ticks do not occur within the limits. The pattern of graduation will vary with the scale of the chart.

3.8.2 Graticule

The graticule is the network of lines representing meridians and parallels on the chart.

3.9. STRAIGHT LINES AND DISTANCES

An important factor in the boundary delimitation between States is to clearly define the nature of the "straight lines" that are to be used to join adjacent turning points. The following “curves” have been used for "straight lines".

3.9.1 Geodesic

The Geodesic also called a geodetic line is a curve giving the <u>shortest distance</u> between two points on a given surface. In the context of this manual it is assumed that the geodesic is calculated on a specific reference ellipsoid. (Generally, a geodesic is neither the line of sight, nor the chord, nor a plane curve). It will normally appear as a curve on a map projection.

3.9.2 Great Circle

A Great Circle is a circle drawn on the surface of a sphere, where the centre of the circle is coincident with the centre of the sphere. The shortest distance between two points on the surface of a sphere is defined by the segment of the Great Circle that passes through those two points.

3.9.3 Loxodrome / Rhumb Line

A loxodrome or rhumb line is a true straight line on a Mercator chart. Projected back onto the reference ellipsoid, it will generally differ from the geodesic curve and will generally not be a plane curve (see Figures 3.13, 3.14, and 3.15). A loxodrome has a constant azimuth. The difference between a loxodrome and geodesic can be significant, depending upon the length and direction of the line and its latitude (see Figure 3.16).

3.9.4 Normal Section

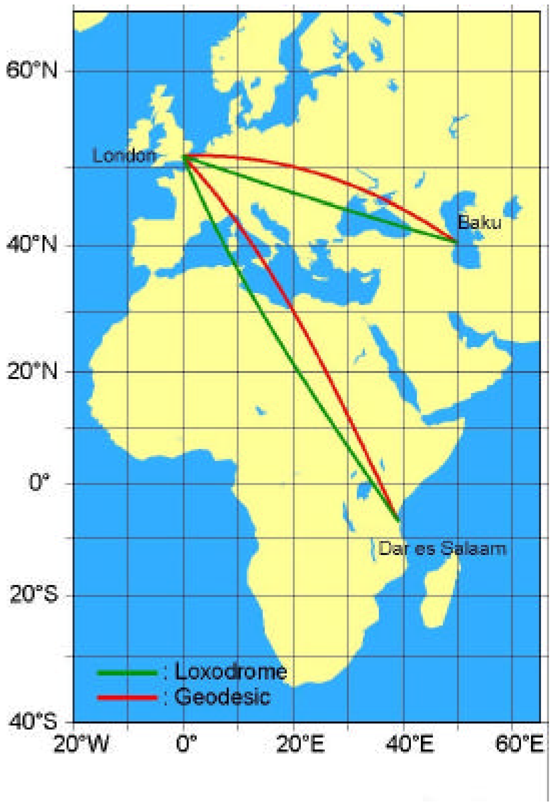
On a reference ellipsoid, the normal section is the curve obtained by intersecting the ellipsoid with a normal plane, i.e. a plane that contains the normal to the ellipsoid at one of the end points. If the ellipsoid had no flattening, i.e. it were a sphere, then all normal sections would be great circles because all normal planes would pass through the centre of the sphere.

3.9.5 Chord (on a mapping plane)

The chord is a straight line connecting two points on the map surface. On the Mercator projection the chord coincides with the loxodrome. Chords are generally not plane curves on the ellipsoid.

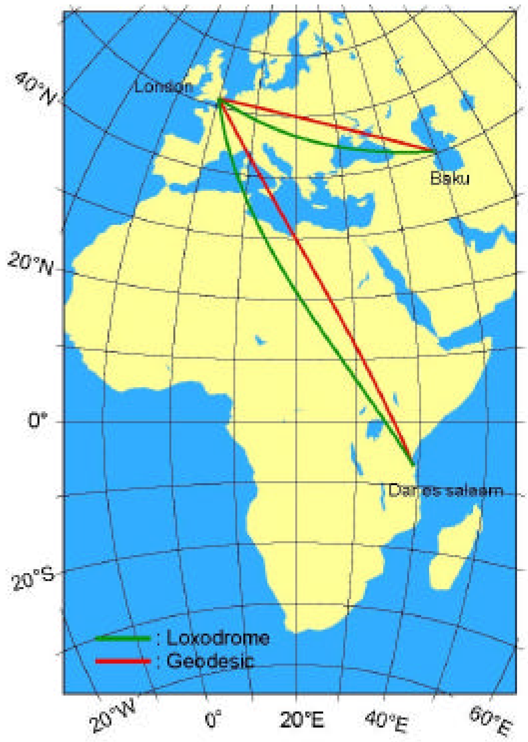
3.9.6 Line of Constant Bearing

Sometimes abbreviated as the "bearing", this line can have different shapes according to the meaning of the term “bearing”. If geodetic bearing (azimuth) is specified then the line coincides with the loxodrome. Generally it is a curved line on the map, and not a plane curve on the reference ellipsoid.



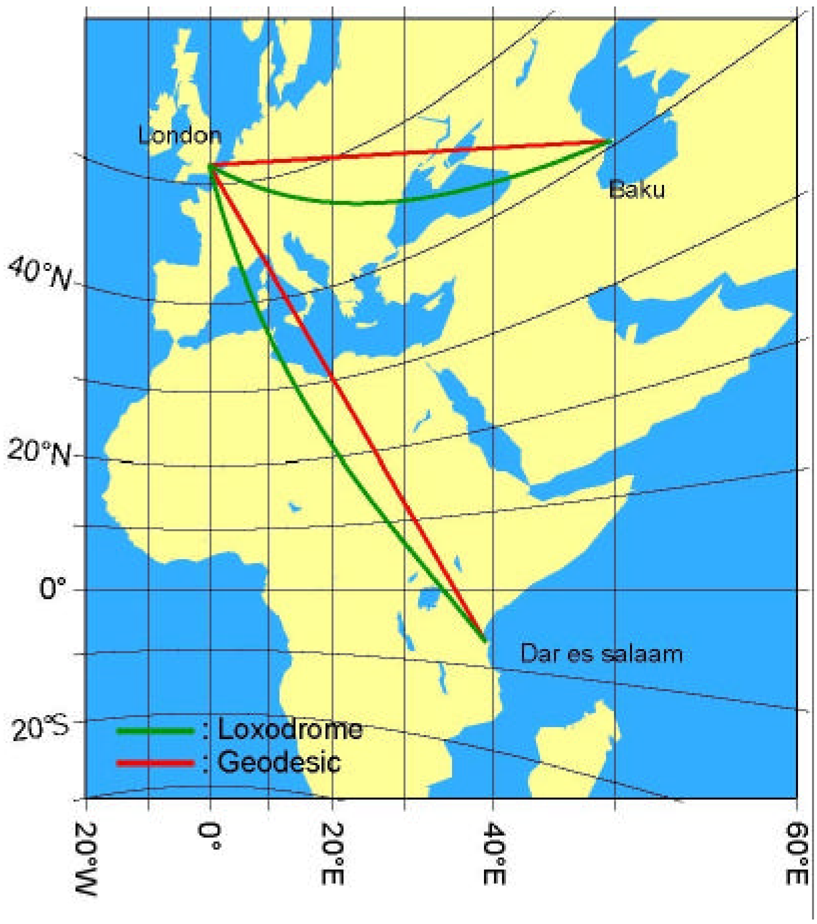
MERCATOR

Figure 3.13 - Loxodrome and geodesic on a Mercator chart



TRANSVERSE MERCATOR

Figure 3.14 - Loxodrome and geodesic on a Transverse Mercator chart



GNOMONIC

Figure 3.15 - Loxodrome and geodesic on a gnomonic chart

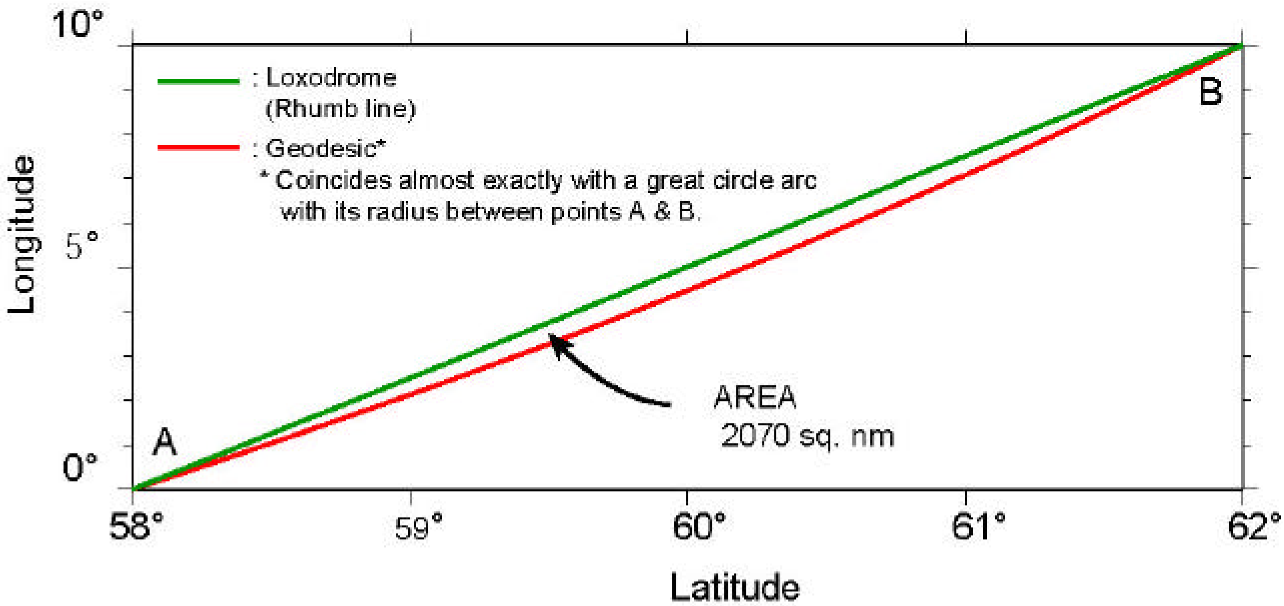


Figure 3.16 - Comparison between a loxodrome and a geodesic connecting two points

3.9.7 Straight Lines on Charts

In baseline descriptions and in boundary definitions, the term "straight line" is frequently used, so it is necessary to appreciate that a "straight" line on one projection may not appear as a "straight" line on another.

On a Mercator projection the equator and all meridians appear as straight lines, and as they are also great circles, they must represent a straight line “shortest distance” on the earth's surface. But parallels of latitude are also shown as straight lines, and they are not great circles; in fact the equator and the meridians are the ONLY great circles shown as straight lines on a Mercator chart. All other great circles will plot as curved lines with their centres of curvature on the side away from the nearest pole (Figure 3.17).

Figure 3.17 - Part of the North Atlantic Ocean on the Mercator Projection, showing great circle (curved) and rhumb-line (straight) paths between Halifax and Lerwick

At first sight this seems to be a contradiction, since it suggests that a curved line between two points is shorter than a straight line. But earlier it was explained how the scale of the projection increases towards the poles, so that a given measurement on the chart will represent greater terrestrial distances near the equator than near the poles.

In Figure 3.17 it can be seen that the great circle appears longer than the rhumb line. However if this had been plotted on a Gnomonic projection, the same curved line would appear as a straight line and the rhumb line would appear as the longer curved line.

3.10 BEARINGS

The bearing is the horizontal direction of one terrestrial point from another, expressed as the angular distance from a reference direction. It is usually measured from 0° as the reference direction clockwise through 360°. The terms Bearing and Azimuth are sometimes used interchangeably, but in navigation the former customarily applies to terrestrial objects, and the latter to the direction of a point on the celestial sphere from a point on the Earth. A bearing is designated as True, Magnetic, or Compass North (Hydrographic Dictionary, IHO Publication S-32)

3.11 WORKING ON THE CHART

3.11.1 Introduction

When working on boundary delimitations it will be necessary to read off geographical positions from appropriate charts or maps, or to plot geographical positions on them. It may also be necessary to construct boundaries on charts for illustrative purposes, or to assist in identifying the base points to be used in computing a boundary, or in certain cases to determine the definitive boundary. The construction of boundaries and selection of base points is considered in Chapters 4, 5 and 6.

A chart must be treated with care if it is not to give misleading results. Since charts are usually made of paper they are liable to shrink or stretch with changes of temperature and humidity. But provided they are treated with reasonable care, such changes should not significantly affect accuracy. Charted parallels and meridians are generally spaced sufficiently close together to limit the effects of distortion so long as measurements (of bearing, distance, latitude or longitude) are read off as close to the positions being measured as possible. Charts should be maintained in good condition. If possible, the folding of charts should be avoided. They should be stored and transported flat or rolled up. Damp conditions should also be avoided.

3.11.2 The Nautical Mile

As has been explained in Chapter 2, the regular mathematical figure which most closely approximates the true shape of the earth is the spheroid or ellipsoid and this is the figure used by geodesists, surveyors and cartographers. In this representation the equator is a true circle, but the meridians are slightly flattened at the poles (see Figure 3.18).

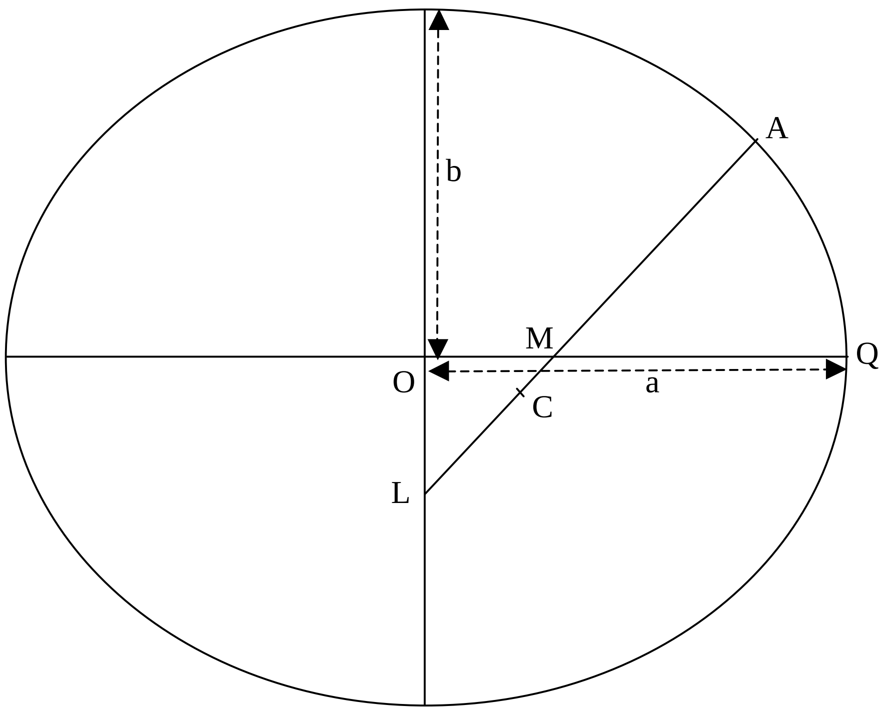


Figure 3.18 – Cross-section through an Ellipsoid, to illustrate polar flattening

The effect is greatly exaggerated in the diagram. In fact the flattening is not great, and the polar ‘diameter’ is about 0.997 of the equatorial ‘diameter’. It can be seen from the diagram, though, that the radius of curvature of a meridian (PAQ) is not constant, and that it is least at the equator Q and greatest at the pole P. Having moved away from the concept of the earth as a sphere, it is necessary to reconsider the basis of the angular measure of latitude: a minute of latitude is correctly defined as the length along a meridian that subtends an angle of one minute at the centre of the radius of curvature. Because of the flattening of the ellipsoid the radius of curvature varies with latitude, and so also must the length of a minute of latitude. It is least at the equator and greatest at the poles. The actual length varies from about 1843 metres to about 1862 metres.

For general navigational purposes these differences are not significant, but where accurate measurements are needed it is convenient to have recourse to a standard length. For this purpose a value of 1852 metres has been adopted as the length of the International Nautical Mile, and is equivalent to the length of a minute of latitude at about 44° latitude. It is the length normally meant when referring to the "nautical mile".

It should be noted that the variation in the length of a minute of latitude on the Earth's surface (or rather on the ellipsoid that represents it) has nothing to do with the continuous change of scale along the latitude graduation of the Mercator projection. The former has to do with the shape of the earth and affects all projections. The latter has entirely to do with a particular method used to represent the earth's curved surface on a flat piece of paper and affects only charts constructed on the Mercator projection. (Other distortions will affect other projections!)

It must be remembered that it is the international nautical mile which is used for describing the breadth of zones such as the territorial sea and EEZ. As described above it is not the same as a minute of latitude except at one particular latitude. For accurate plotting of distances this difference can be significant and must be taken into account.

3.11.3. Latitudes and Longitudes

There are many ways in which a position on the surface of the earth may be defined. The global system that is best known and universally used in marine navigation is that of geographical coordinates, latitude and longitude. In this system, the surface of the Earth is gridded with "parallels of latitude" that are oriented east and west and measured and numbered as angles north and south of the equatorial plane. Perpendicular to these are the "meridians" or lines of equal "longitude" that are oriented north and south and converge at the poles. Conventionally the meridian known as the Prime Meridian, running through Greenwich, UK, is assigned as the zero reference, and the longitude is measured as an angle to the west or east of the Greenwich meridian. On most projections, due to their convergence, the meridians do not cut the parallels of latitude at right angles but the Mercator projection is designed so that the lines of latitude and longitude are perpendicular to each other.

To ease the problems of computing positions on a spherical surface, both latitude and longitude are expressed in angular measure. Latitude is measured from 0 to 90 degrees north or south of the Equator. The Equator is 0°, the North Pole is at Latitude 90° North, and the South Pole is at Latitude 90° South. Longitude is measured from 0° to 180° East, and from 0° to 180° West, of the Prime Meridian. The meridian of Longitude 180° East is the same as the meridian of Longitude 180° West. It lies diametrically opposite the Prime Meridian (of 0°).

The international meridian of zero longitude was originally defined by the rotation axis of the Earth and a specific point located at the former Royal Observatory at Greenwich, near London in the U.K. It has in recent times been modified by international agreement to have a physical location close to, but not identical with, the original line as defined by the International Earth Rotation Service (IERS).

The angular measure of a "degree" (denoted by the symbol °) is usually sub-divided into minutes (') and seconds ("). There are 60 minutes to a degree, and 60 seconds to a minute. It should be noted that mathematical calculations require a high level of precision and that consideration should always be given to providing coordinates to decimals of a second if required. To avoid confusion with units of time or temperature these units of angular measure may be referred to as degrees, minutes and seconds "of arc".

The majority of charts, excepting some older large-scale sheets, are graduated in latitude and longitude. The graduations are shown along the borders of the chart. The inner neat lines of the border are almost always oriented due north-south and due east-west, so that they are meridians (along which the latitude graduation is shown), and parallels (along which the longitude graduation is shown). In addition, a selection of meridians and parallels are shown on the face of the chart, spaced so as to facilitate the plotting or reading of positions. The resulting network of intersecting meridians and parallels is called a graticule

3.11.3.1 Reading Latitudes and Longitudes on Mercator Charts

Two methods are available for reading geographical coordinates from a Mercator chart: one using a parallel ruler and the other using dividers. In the first method one edge of the parallel ruler is aligned with the charted parallel or meridian (depending on whether the latitude or the longitude is required) nearest to the point whose coordinates are to be read off. The ruler should be positioned to overlap both the graduation on one border and the required point. The ruler is then carefully rolled to bring an edge over that point. With a well sharpened pencil held against the edge of the ruler a fine line should be drawn through the point (to check alignment). Then, holding the pencil at the same angle to the edge of the ruler, draw a fine line across the graduation scale on the border. The parallel ruler may then be moved to allow the latitude or longitude of the line on the scale to be read and recorded. Exactly the same procedure is followed for reading the other coordinate. Care must be taken in rolling the ruler to ensure that uneven pressures do not cause it to slew out of parallel. Graduated set squares may be used in lieu of a parallel ruler.

In the second method, dividers are held so that one point of the dividers is placed on the exact position whose coordinates are to be read. The dividers are carefully adjusted so that the other point just touches the nearest charted parallel or meridian, as appropriate, due north or south, or due east or west, of the position to be read. The dividers are then placed against the appropriate border graduation nearest to the position to be read, with one point at the intersection of the charted parallel or meridian and the graduation. The latitude or longitude indicated on the scale by the other point of the dividers is that which is required.

It takes practice to learn how to hold the dividers at an angle to the paper so that the points are on the required positions but not sticking into the paper. If the points are continually pushed in, the exact position on the chart will become obscured by the resultant damage to the paper.

Charts used to be engraved on copper printing plates. Subsequent corrections were made by hammering out the engraved work in the relevant area before inserting the corrected detail. The hammering inevitably slightly distorted the plate in the area of the correction, and frequently one or more of the charted parallels or meridians would be bent. Although there are probably no charts in current use that have been printed directly from copper, many older charts have been transferred to more modern plates, and the distortions will have been transferred also.

If at all possible, charts based on old plates should be avoided, and alternative sources or charts should be sought. That may not always be possible, however, in which case considerable care must be taken, and it must be recognized that the results will probably be less accurate than is desirable. In these cases the parallel ruler method is often to be preferred because the rulers may be aligned along a sufficient length of parallel or meridian for the effect of local distortions to be eliminated. It may, however, be impossible to find an alignment that is entirely satisfactory, and in particular, if the position is near the middle of the chart, comparison of intersections with opposite borders may show a discrepancy. It may be necessary to take a mean of two readings.

3.11.3.2 Plotting Positions by Latitude and Longitude on Mercator Charts

On a Mercator chart, plotting a position is the reverse of the parallel ruler method of reading it from the chart. The ruler is aligned on a parallel or meridian as near the required position as possible, and overlapping both the appropriate border graduation and the longitude or latitude of the position. It is then carefully rolled to a point where a fine pencil line can be inscribed across the graduation at the required latitude or longitude. Another line is inscribed of sufficient length to be sure that it will pass through the desired position to be plotted. This is repeated for the other coordinate, and the intersection of the two lines marks the position.

3.11.4 Use of Bearings and Distances on Mercator Charts

Plotting positions on a chart by a bearing and distance from a known charted position may be required in boundary delimitation. However, it is only accurate (within the limitations of scale) over quite short distances because of the problems of distance measurement on the Mercator projection, or because of the difficulty of projecting a line of constant bearing on non-Mercator projections which depict meridians as converging lines.

The bearing is measured either with reference to a nearby meridian using a protractor or specially designed parallel ruler, or it may be made with reference to the compass roses, which will be found located at convenient points on the chart. In the case of the latter, great care should be taken in using the compass circle referenced to true and not magnetic north. After drawing the line of bearing, the distance may be measured either with reference to the latitude scale (at the same parallel at which the measurement is being made), or to the distance scale on non-Mercator charts. The distances can be set off using dividers.

A position determined by bearing and distance is generally described as being so many degrees and such and such a distance from a specific feature (which may be called the reference point) which is either defined by precise geographical coordinates or is clearly identifiable as an unambiguous point on the chart. Such an identifiable feature might be a lighthouse or a beacon; if it cannot be identified as an unambiguous point the accuracy of the position is immediately in question. That might occur if the feature were a rounded headland.

Compass bearings are usually given in "whole circle" notation from 0° to 360° where true North is both 0° and 360°, and bearings are measured clockwise (i.e. towards east, south and west in that order). Alternately, they may be given in quadrantal notation e.g. N36E, although this notation is rarely used today. They may, of course, be expressed in the form of degrees and decimals of a degree, degrees and minutes (and decimals of a minute), or they may be given in degrees, minutes and seconds (and decimals of a second). But if the position has been taken off a chart, or has been determined by compass bearings it can only have been read off to within about a quarter of a degree (15'). Distances, which will be quite short if this method is being used (see above), are most likely to be given in nautical miles (probably without regard to the difference between a minute of latitude and the International Nautical Mile - see earlier text).

3.11.5 Working on Non-Mercator Charts

The positions of base points must generally be determined by reference to the largest scale chart available. Where existing charts are inadequate, precise geographical coordinates may have to be taken off a large-scale land map of the area. Large-scale charts may be found to be on a non-Mercator projection, and it is almost certain that no land map of the type being considered would be on the Mercator projection.

At the large scales likely to be used in these instances, the convergence of the meridians and curvature of the parallels which occur on other projections will be practically undetectable within the bounds of adjacent mapped or charted meridians and parallels. In that case plotting by latitudes and longitudes may be carried out as already described. Readings should always be taken by reference to the nearest set of graduations.

If the curvature of the parallels is detectable between the area concerned and the nearest latitude graduation, it will be necessary to inscribe a meridian by joining the appropriate longitude graduations at the required position. The latitude difference from the nearest parallel (taken off with dividers) may then be referred from this inscribed meridian to the border graduation or vice versa.

Similarly, if the convergence of the meridians is such that different readings would be obtained from the lower and upper border graduations, it will be necessary to inscribe a local meridian by connecting like values along the two graduations as near as possible to the required position. Use the dividers to measure the longitude difference between this meridian and the desired position and then transfer it to the nearest graduated border for reference. This reduces the chance for significant error.

On many maps the main positional reference system is provided by a square grid. These generally refer to distances (usually in metres or kilometres) north or south, and east or west, of a local Point of Origin. Despite the use of the familiar terms "north" and "east" these 'rectangular spheroidal coordinates' cannot be converted to latitude and longitude by a simple process of adding or subtracting some fixed value. Such grids often have much closer mapped sub-divisions than is provided for the geographical graduation, and may be much more convenient to use. The local (or national) grid coordinates so obtained can be converted to geographical coordinates using an appropriate formula, a time-consuming process without the aid of a computer and appropriate software!

A feature of many large-scale maps is that the borders frequently do not show close latitude and longitude graduations, and often there are no continuous lines denoting meridians or parallels. Furthermore, if the map is gridded the borders are unlikely to be oriented north-south and east-west. In such cases intervals of latitude and longitude are shown around the border, but often widely spaced and with no intermediate values. Their points of intersection may be indicated on the map by small crosses. By joining the appropriate intersection points with pencilled lines a local graticule can be constructed.

The lack of any sub-division of the border graduation should present no difficulty. The appropriate distances to the nearest meridians and parallels may be read off a ruler graduated, preferably, in millimetres. These distances may be compared with the measured distances between adjacent meridians or parallels, and by simple proportion the interval may be converted to a difference of latitude or longitude. There is no problem of a constantly changing latitude scale as is found with Mercator. (Changes of scale do occur with these projections, but they are seldom significant for plotting purposes. They are, however, significant if computational precision is required, and calculations of positions using the mathematics of the projections have to take this into account).

3.11.6 Working on Electronic Navigational Charts within ECDIS

Functionality within an ECDIS will normally allow the plotting of positions or the display of the co-ordinates of positions on an ENC with much greater ease than that described above for paper charts.

CHAPTER 4 - BASELINES

(The reader of this Section is advised to refer to a more detailed treatment of the subject contained in the U.N. Publication E.88.V.5 Baselines: An Examination of the Relevant Provisions of the United Nations Convention on the Law of the Sea)

TABLE OF CONTENTS

4. BASELINES

This chapter addresses three types of baseline: normal, straight, and straight archipelagic.

The normal baseline is the basic element from which the territorial sea and other maritime zones are determined. It is defined as the low water line along the coast, as marked on large-scale charts of the coastal state (Article 5).

Straight baselines are defined by straight lines that join points on the coastline which have been selected according to the criteria listed in Article 7. They delineate internal waters from territorial seas and other maritime zones.

Straight archipelagic baselines define the periphery on an island group by joining the outermost islands with a succession of straight lines constructed in accordance with Article 47.

4.1 THE NORMAL BASELINE

The general definition of the normal baseline comprises the elements addressed in UNCLOS Articles 5, 6, 11, and 13, namely the low-water line along the continental shore and around islands, including the outer limits of permanent harbour works, the low-water line around certain low-tide elevations, and the seaward low-water line of atoll reefs and of fringing reefs around islands.

In well surveyed and well charted areas, the low-water line is clearly depicted on large scale nautical charts. Usually the largest scale chart of any section of low-water line will incorporate the most recent survey results, and will depict them in most detail. However, it should be noted that in many parts of the world the area between the high-water line and the 5 metre isobath is often based on old data. As mentioned in Chapter 3, the low-water line corresponds to the local level of chart datum. In places where there is little or no tidal range, or where the coast is very steep, no area may be visible between the high- and low-water lines depicted on the chart. In that case, the coastline that is shown on the chart may be taken as the normal baseline.

On older charts, particularly in areas where there are numerous sandbanks or near-shore reefs, or where in general the shallow water features may be rather complex, the symbols used may not always make a clear distinction between the low-water line and shallow water contours. Sometimes the representation is intended more to indicate the presence of a feature, than to specify its precise nature. Sailing Directions (which are normally published by the publisher of the chart) may provide some assistance in resolving whether or not an isolated shoal or reef is a low-tide elevation. In some cases, it may be possible to resolve the problem through reference to more modern land maps, or by inspection of aerial photography that may have been used in the construction of the original charts. If there is serious doubt, the matter should ideally be resolved with a field survey operation. If the area has a low tidal range, high resolution satellite imagery may be considered, provided a resolution of about ± 30 metres is acceptable.

There may be instances where the only available charts are based on inadequate geodetic control. Not only may there be an overall positional discrepancy, but there may also be errors in the relative positioning of the different topographical features. This can only properly be resolved by a new survey. If bilateral boundary negotiations cannot be delayed for the considerable time needed to carry out such work, the best supplementary information available should be used, which will usually be found on a land map. If systematic aerial photographic coverage of the region is available, an aero-triangulation may be carried out in order to position the actual coastline (low water mark) or the potential base-points. This method of coordinate determination is often superior to coordinates taken from maps. High resolution satellite imagery can again be considered.

Article 5 requires that the low-water line which defines the normal baseline should be determined from charts which are officially recognized by the coastal State. Not all coastal States publish their own charts, and for many coastal areas, it could be years before charts are produced at scales suitable for baseline definition. In such cases, it is recommended to adopt if possible the charts published by the State that undertook the primary charting.

When referring to charts, maps, aerial photographs or other documents, care should be taken to always use the most recent and up-to-date editions. In addition, it is important to verify that corrections issued after a given chart's publication date have been incorporated.

4.2 THE STRAIGHT BASELINE

A baseline may be defined by one or more sections of straight line in circumstances specified by UNCLOS:

a. across the mouth of a river;
b. across the mouth of a juridical bay or a historical bay;
c. as part of a system of straight baselines;
d. as an archipelagic straight baseline

When considering the application of any of these relevant UNCLOS Articles, the technical provisions of the relevant Articles must be carefully studied, even though truly objective criteria are not always provided.

4.2.1 Mouth of a River

If a river flows directly into the sea, the baseline shall be a straight line across the mouth of the river between points on the low-water line of its banks (Article 9).

4.2.2 Bay Closing Line

The determination of juridical bay closing lines is a complex operation, with detailed and objective criteria provided by Article 10. UNCLOS provides for closing lines only in juridical bays where the coasts belong to a single State. The treatment of historic bays is less well defined, and is mentioned in Article 298 within the context of dispute resolution.

Two distinct determinations must be made in developing the closing line of a juridical bay: whether a well-marked indentation exists; and the locations of appropriate points to define the ends of the closing line(s).

The identification of "natural entrance points" may present difficulties, although the requirement of the Convention is that the bay should be a "well-marked indentation". Difficulties may exist in this determination when there are islands in the entrance of the bay, or where one side of the bay curves gently inwards from the general direction of the coast. There is no universal agreement for determining natural entrance points, although some States have developed their own methods. A bay has more than one entrance point if one or more islands are situated at the mouth of the bay. The term "low-water mark" is used in Article 10, which has been consistently interpreted as being synonymous with the term "low-water line".

UNCLOS specifies some objective tests to determine whether or not a well-marked indentation is a juridical bay by comparing two areas (see Figure 4.1):

a. the area (A1) of a semi-circle the diameter of which is equal to the length of a line joining the bay's natural entrance points. If there is more than one mouth, then the diameter (twice the radius r) of the semi-circle is to equal the sum of the lengths of the lines joining the entrance points of the different mouths. The area may be approximately calculated using the normal rule for the area of a semi-circle on a plane. For critical cases where a more precise result is needed, geodetic methods should be used.

b. the area (A2) of the waters of the indentation enclosed by the lines across the entrance points and the shore (low-water line) of the indentation. The area of any islands within the indentation is to be included as part of the water area.

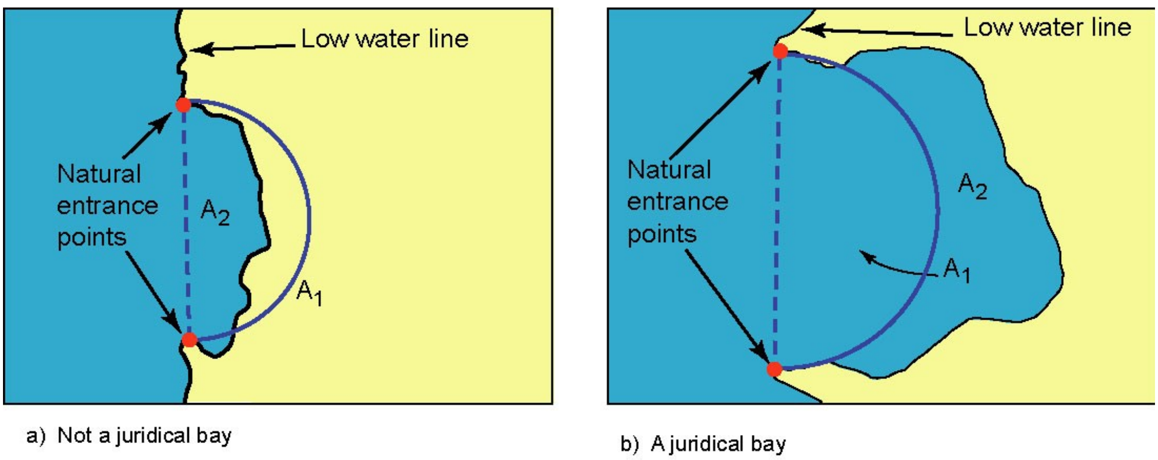


Figure 4.1 – Juridical bay

It may be seen in Figure 4.1a) that the area A2 bounded by the bay closing line and the low water line of the indentation is smaller than the area within the semi-circle A1 and, hence, it does not qualify as a juridical bay.

In figure 4.1b the area A2 bounded by the bay closing line and the low water line of the indentation is larger than the area of the semi-circle A1 and therefore does qualify as a juridical bay.

Having determined that an indentation is a juridical bay, it then becomes necessary to consider where the closing line(s) may be placed. The critical parameter in this process is the length of the closing line between entrance points, or the combined lengths if there are two or more closing lines. For the purposes of this discussion, that length will be referred to as the "closing length".

If the closing length does not exceed 24 nautical miles, then the line or lines may be used to close the bay. If the closing length exceeds 24 nautical miles, it will be necessary to develop a new and shorter closing line within the bay. Usually, this location is not difficult to determine, since a brief inspection of the chart should identify its approximate position.

It frequently happens that a single large indentation may have a number of smaller indentations around its shores, some of which may individually satisfy the criteria of a juridical bay. If the large indentation has a mouth that is greater than 24 nautical miles wide, it may not be acceptable to close it off as a juridical bay, however the smaller indentations can be treated as juridical bays if they satisfy the conditions individually.

If A1 is greater than the area of the bay, the indentation may not be considered a juridical bay, and may not be closed. Sub-indentations may exist within the main bay, and some of these may individually satisfy the conditions for a juridical bay. Islands within an indentation must be considered as part of the water area when testing whether the indentation may be treated as a bay.

4.2.3 Straight Baseline System

Article 7 permits a coastal State to draw straight baselines in place of or in combination with normal baselines, i.e. the coastal low-water line, provided certain conditions specified in the Article are met, namely:

> "Where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity."

The rationale for allowing straight baselines in these circumstances is to obviate the determination of highly irregular normal baselines which in turn would generate similarly irregular outer limit lines of maritime zones. While the LOS Convention itself contains no criteria or guidance as to what constitutes a coastline which is "deeply indented and cut into" or "fringe of islands", a detailed discussion of this subject is contained in the UN Publication Baselines. This publication also elaborates on what may constitute "fringe of islands" and "immediate vicinity". In the paragraphs that follow, extracts from this publication are presented as quotations, followed in some cases by amplifying comments:

> "Where a coastline is highly unstable due to the presence of a delta or other natural conditions, base points may be selected along the furthest seaward extent of the low-water line."

The instability may be checked by comparing modern surveys, maps, aerial photography, etc., with older ones. The reliability of the conclusions will depend to some extent on the duration of the study period: some coastlines are subject to large short-term changes whilst retaining relative stability over the long term. This provision should not be confused with Article 9 which deals with the closing of river mouths.

> "Straight baselines must not depart to any appreciable extent from the general direction of the coast."

From a technical standpoint, this refers to the angle of convergence or divergence between the general direction of the coastline, however it may be determined, and the bearing of a proposed straight baseline. In this context it is also noteworthy that UNCLOS does not specify any maximum permitted length for a straight baseline.

> "Sea areas lying within straight baselines must be sufficiently closely linked to the land domain to qualify as internal waters."

There is no definitive mathematical criterion for determining what is "closely linked" in terms of physical proximity.

> "Straight baselines may be drawn to and from low tide elevations only where lighthouses or similar installations have been built permanently above sea level on such elevations. An exception is provided for instances where general international recognition has been given even if the above condition has not been met."

> "In determining particular straight baselines, economic and historical factors peculiar to the region concerned may be taken into consideration."

> "It is prohibited to draw straight baselines in a manner such that it prevents access by another State from its territorial seas to either the high seas or an exclusive economic zone."

4.3 STRAIGHT ARCHIPELAGIC BASELINES

Article 46 states the defining characteristics of an archipelago and of an archipelagic state. Article 47 contains specific technical criteria for the construction of archipelagic baselines.

Archipelagic baselines must encompass the main islands of the archipelago, although "main islands" are not clearly defined in Article 47. Within the area enclosed by the baselines, the ratio of area of water to area of land must be between 1:1 and 9:1. The area of land may include the area of any atolls, islands, drying reefs and enclosed lagoon waters, also waters lying within the fringing reefs of islands.

Baselines must not depart to any appreciable extent from the general configuration of the archipelago. As with 'general direction of the coast', this is a subjective criterion. In most cases it is probable that the archipelagic baselines will themselves suggest the general configuration of the archipelago.

The length of the individual baselines must not exceed 100 nautical miles, except that up to 3 per cent of the total number of archipelagic baselines may be up to 125 nautical miles in length. There is no limit to the number of baseline segments that may be drawn. If, however, in order to include a number of segments of more than 100 nautical miles, it is decided to increase the number of shorter lines, so that the 3 per cent criterion is satisfied, care must be taken that the other criteria are still satisfied.

Baselines (see Figure 4.2) may be drawn to join the outermost points of the outermost islands and drying reefs of the archipelago. But they cannot be drawn to and from a low-tide elevation unless: (a) a lighthouse or similar installation which is permanently above water has been built upon it; or (b) the elevation is situated wholly or partly within the breadth of the territorial sea from the nearest island. These provisions differ from those of Article 7(4) for a system of straight baselines.

Article 47(5) which requires that the system of archipelagic baselines "... shall not be applied ... in such a manner as to cut off from the high seas or the exclusive economic zone the territorial sea of another State."

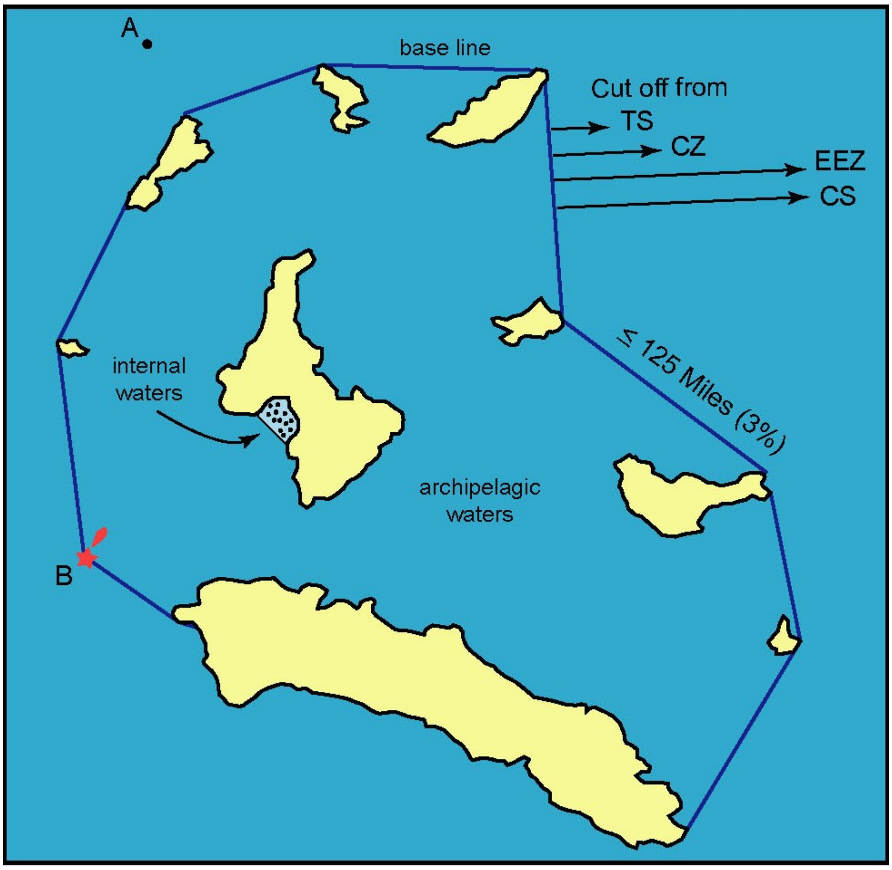


Figure 4.2 - Archipelagic Straight Baselines (after Francalanci and Romano, 1986) TS: Territorial Sea; CZ: Contiguous Zone; EEZ: Exclusive Economic Zone; CS: Continental Shelf; A: Low tide elevation with no navigational mark; B: Low tide elevation with navigational mark.

4.4 ISLANDS

Even on a detailed chart, it is not always possible to determine whether a small feature is a natural island, an artificial island, or a low-tide elevation with a structure built upon it. It may be possible to resolve the matter by reference to the Sailing Directions. Failing that, it may be necessary to undertake a visual inspection or a hydrographic survey, to determine if the feature is a low-tide elevation or an island.

An island is defined in Article 121(1) as any naturally formed area of land that is surrounded by water and which is above water at high tide. The low-water line surrounding such a feature, regardless of its size, may form the baseline or a part of the baseline from which to measure the maritime zones. If the feature is a rock which cannot sustain human habitation or economic life of its own, then it cannot have an exclusive economic zone or continental shelf. UNCLOS does not explicitly define what a rock is, nor does it distinguish a rock from an island.

According to Article 7(1), a fringe of islands near the coast may be used to establish straight baselines.

4.5 PARTICULAR CASES

Some particular circumstances pertaining to baselines must be studied. They represent exceptions or limitations to the application of the "normal baseline". They are: coastal installations, offshore installations, low-tide elevations and reefs. Mention will also be made of the termination of a system of straight baselines at a boundary between two States.

4.5.1 Coastal Installations

Article 11 states that "...permanent harbour works which form an integral part of the harbour system are regarded as forming part of the coast". It has been generally recognized that these include all permanent works, such as harbour jetties, breakwater etc., and also such coast protection works as sea walls which have obscured the natural low-water line. They do not include structures, such as might carry sewage outfalls etc., which are not part of a harbour work and are not associated with coast protection.

4.5.2 Offshore Installations

Such features, which include artificial islands, do not possess the status of islands and do not form a part of the baseline. They have no territorial sea of their own. Note, however, that in some circumstances straight baselines or archipelagic baselines may be drawn to and from low-tide elevations which have lighthouses or similar installations that are built upon them and which are permanently above water, (Articles 7 and 47).

4.5.3 Low-tide Elevation (Article 13)

A naturally-formed low-tide elevation may be part of the "normal" baseline only if all or a part of the elevation lies within the breadth of the territorial sea, measured from the mainland or an island. If the low-tide elevation lies wholly outside the breadth of the territorial sea measured from the mainland or an island, it may not be used as part of the baseline (see Figure 4.3).

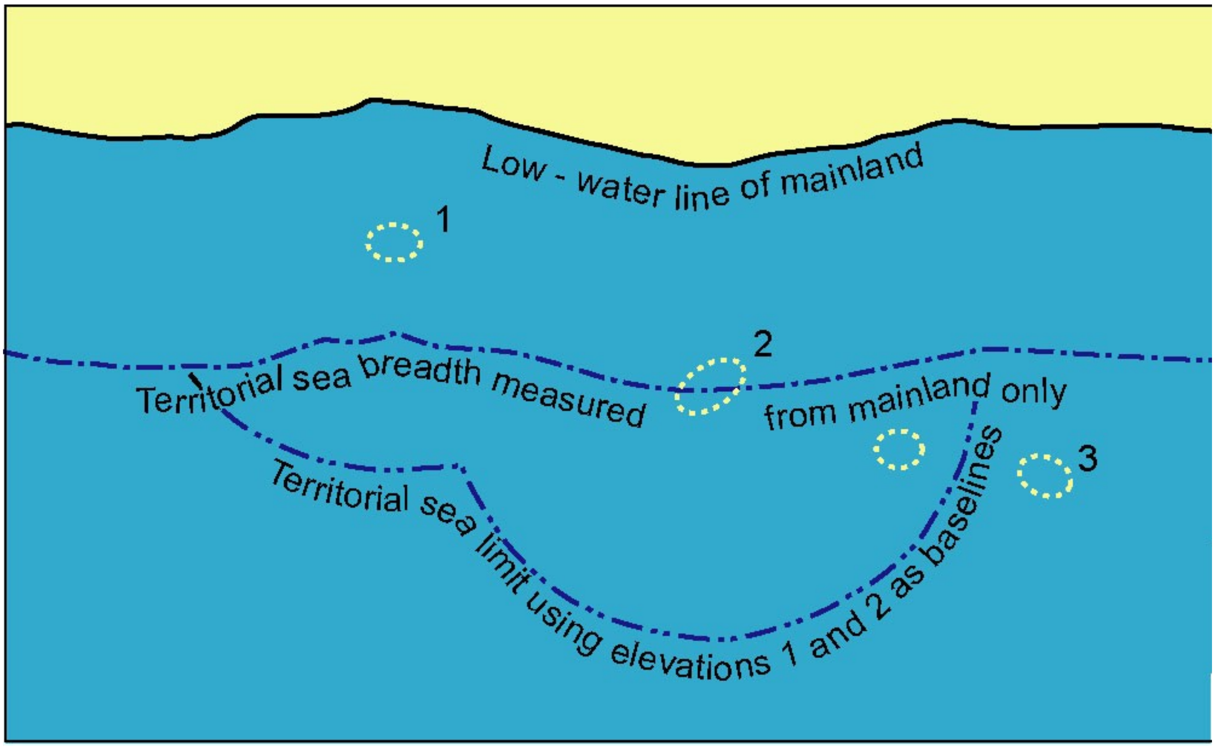


Figure 4.3 - Low-tide Elevation

Straight baselines may be drawn to low-tide elevations only if they have a lighthouse or similar installation permanently above sea level built on them, except in instances where the drawing of the baselines to and from such elevations have received general international recognition.

Straight archipelagic baselines may be drawn to low-tide elevations if they meet the criterion of distance (as for the normal baseline), or if they have a lighthouse or similar installation built upon them that is permanently above water.

4.5.4 Reefs

In the case of an island situated on an atoll or having fringing reefs, the baseline is the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognized by the coastal State (Article 6).

The charting of coral reefs requires some explanation. Coral reefs are constructed by organisms which can only live in shallow waters, and cannot survive prolonged aerial exposure. By their nature, therefore, reefs of live coral cannot extend much above the low-water line, and their tops tend to be planed off by wave action. Typically, in fact, the shallowest part of the reef may extend over a considerable area as a plateau which is just below low-water level for the most part, but which features numerous small growths of coral that extend just above the low-water level. Such areas are not navigable by anything but very small boats or canoes, and their seaward edge is generally unapproachable on account of breaking waves.

Customarily, areas of reef plateau are charted as a single area of drying coral since it is impossible to chart all the individual lumps and heads, and the area is for practical purposes un-navigable. The symbol for drying coral is used to illustrate the extent of this feature on a chart, and it is the edge of this symbol that is taken as the "... seaward low-water line of the reef, as shown by the appropriate symbol ...". On some charts, actual depths may be shown over a coral area that is charted with the drying coral symbol. Usually, this merely indicates that the surveyor was able to obtain some depths between the numerous obstructions.

Isolated reef patches that are charted by the appropriate symbol and which are not part of an atoll formation are to be considered as ordinary low-tide elevations, and treated as such.

4.5.5 Straight Baselines at a Boundary

While it is not explicitly stated in the Convention, except in the case of Bays (Article 10), a straight baseline is not expected to be drawn from a base-point in one State to a base-point in another State. Usually, the system should terminate at a point on the low-water line of the State utilizing the straight baselines. Nevertheless, cases do exist in practice where straight baselines have been drawn between States.

4.6 PUBLICIZING THE BASELINE

In accordance with Article 16, baselines must be published either on a chart or by a list of geographical coordinates. In general the "normal baseline", consisting of the low-water line, is most conveniently shown by use of the existing officially recognized charts. It would be an excessively tedious task to list sufficient geographical coordinates to define the whole low-water line in the necessary detail. Straight baselines, on the other hand, may be easily and accurately defined by listing the geographical coordinates, referred to a defined geodetic datum, of the terminal points of each segment.

If there are no charts officially recognized by the coastal State, it will be preferable to construct a special baseline chart on which to promulgate the baselines that have been determined, whether "normal" or straight or a combination of them. If this course is adopted, the choice of scale is important. This will be dictated by the accuracy that is required to enforce the laws applicable within the zones which are measured from the baselines. In order to read off a position on a chart to, say, the nearest 30 metres (about 1 second of arc in latitude), the chart would need to be of a scale of about 1:75,000, but that is an inconveniently large scale on which to show any considerable length of coast. In most cases scales of between 1:100,000 and 1:250,000 will be adequate to display the baselines.

The requirement for high accuracy in defining the baselines and the boundaries that are derived from them is primarily imposed by the need to manage and control significant offshore resources such as hydrocarbons and minerals. Geodetic techniques may well be required to achieve that high level of accuracy.

Geographical coordinates defining base points are usually given to the nearest second in latitude and longitude; greater precision can sometimes be achieved if the base data is accurate enough.

4.7 GEODETIC COMMENTARY: SURVEYS, LINES, AND AREAS

Section 6 of Chapter 2 contains a comprehensive review of the geodetic and survey issues that are critical to accurate baseline determination. That section should be read in conjunction with the present chapter.

When defining straight baselines it is important to state whether they are loxodromes (also known as rhumb lines) or geodesics, particularly if they are long lines. A loxodrome appears as a straight line on a Mercator projection, where every point along its length maintains a constant azimuth relative to the line's start or end point. A geodesic, on the other hand, defines a line on a curved surface (usually the reference ellipsoid) that traces the shortest distance between its two end points. Except in special situations, a geodesic plots as a curved line in most projections (even when it defines a "straight" baseline), and points along its length define varying azimuths relative to the start and end points.

The difference between a loxodrome and a geodesic increases with latitude and with the length of line. For example, at latitude 60 and with end points separated by 45 nautical miles, the maximum separation between a loxodrome and a geodesic could be 236 metres. At a chart scale of 1:200 000, this difference amounts to just a little over 1mm and is negligible to all intents and purposes. But when defining the longest archipelagic baseline permissible (125 nautical miles), the separation between a loxodrome and a geodesic at the same latitude could be as much as 1820 metres, or nearly a full nautical mile. In that situation, the difference between the two possible "straight" lines is very significant, which could have important consequences in boundary determination.

Situations arise where it is necessary to calculate the area enclosed by straight baselines, e.g. when working with bays and archipelagos. Generally speaking, the size of the area will vary according to the surface that is used for its description, and for the definition of the circumscribing baselines. When the baselines are straight on a map, the projected area can be evaluated fairly simply by using analytic geometry. Unless the work is carried out in an equal-area map projection, however, the projected area has then to be adjusted to account for the map distortion in order to obtain the correct value, i.e. the area on the horizontal datum. This is not a simple task and is better left to a specialist in mathematical cartography. Several GIS software applications are available which will calculate the area of a polygon on the ellipsoid. The definition of the closing lines of the polygon is again essential for an accurate result.

CHAPTER 5 - OUTER LIMITS

TABLE OF CONTENTS

5.1 GENERAL

This section discusses the definition of the seaward or outer limits of a coastal State's maritime zones where the limit is determined as a maximum that may be claimed under the LOS Convention, in the absence of overlapping claims by neighbouring States. It assumes that the baselines have already been determined as discussed in Section 4

Except in the case of the continental shelf, where it extends beyond 200 nautical miles in accordance with the provisions of Article 76, the outer limit may be defined by specified distances measured from the baselines. Typically this is 12 nautical miles for the Territorial Sea, 24 nautical miles for the Contiguous Zone and 200 nautical miles for the Exclusive Economic Zone (EEZ). The precise determination of these limits requires an application of the geodesy discussed in Section 2. The limits may be also be prescribed by graphic geometric means, however this method is less precise and is not recommended.

Two matters should be noted

i) The outer limit of the continental shelf may coincide with the EEZ or it may extend beyond it if the provisions of Article 76 are satisfied. This limit forms the boundary between the coastal State and the Area as defined in Part XI of the LOS Convention.

ii) Although in accordance with the LOS Convention (Art 121) islands are treated identically to other land territories, rocks which cannot sustain human habitation or an economic life of their own shall have no exclusive economic zone or continental shelf.

5.2 LIMITS BASED ON DISTANCE

Limits based on distance will either take their point of origin from a normal baseline or from a system of straight lines. Geometrically and when dealing with short distances, a straight baseline system will result in an approximate system of straight lines and arcs of circles, while the normal baseline will result in an approximate simulation of the low water line itself. It will be noted that deep coastal indentations tend not to be fully reflected in the limits because distances measured from opposite sides of an indentation intersect at a point which is situated to seaward (Figure 5.1).

Due to the fact that the Earth is not flat and that all projections result in some distortion (see Section 3.5), the use of traditional graphical methods for constructing limits and boundaries should be restricted to limited areas and limited distances. A long straight baseline, for instance, may be defined as a geodesic or loxodrome, and derivation by purely graphical means could be subject to error. In a related vein, limits that are more than 24 nautical miles from the baselines should always be derived by geodetic techniques in order to take into account the curvature of the Earth. The limits can be constructed directly on a chart, but it is necessary to take into account the variation of scale that exists on many projections.

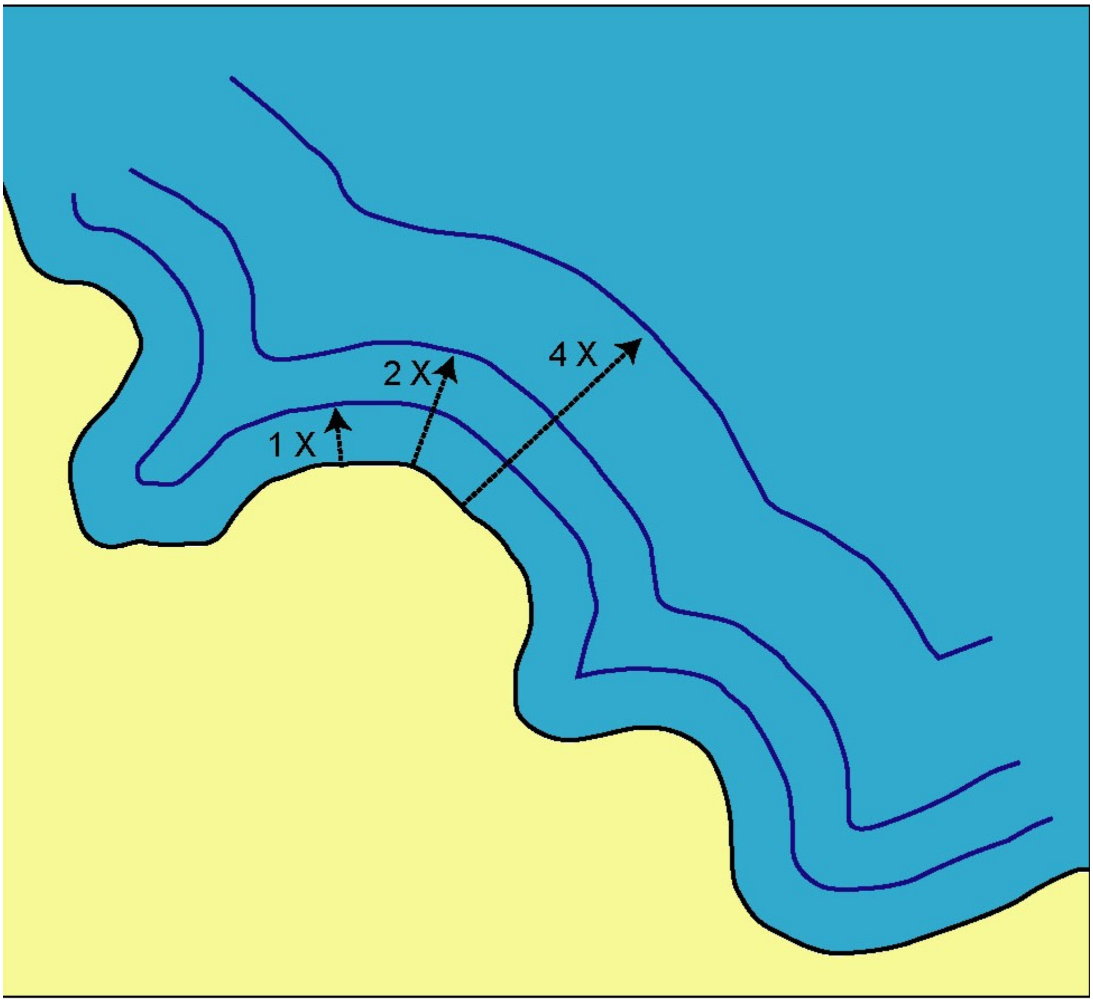


Figure 5.1 - Many limits consist of lines where each point is located at a fixed distance from the territorial sea baseline. Limits that are situated farther offshore have a lesser tendency to reflect the sinuosity of the baseline.

For descriptive purposes, it is advantageous to disregard the complexities of a curved surface, so for the purpose of this Section the terms of plane geometry will be used. However it must be understood that in practice the calculations should be made in geodetic terms, and the "circles" and "straight lines" will not rigorously project into true circles and straight lines on any mapping projection.

In plane geometric terms, the unilateral limits at x nautical miles from the baseline are (see Figure 5.2):

- For a straight baseline, a straight line parallel to it at a distance of x nautical miles.
- For a base point, a circle of radius x nautical miles centred on the point.

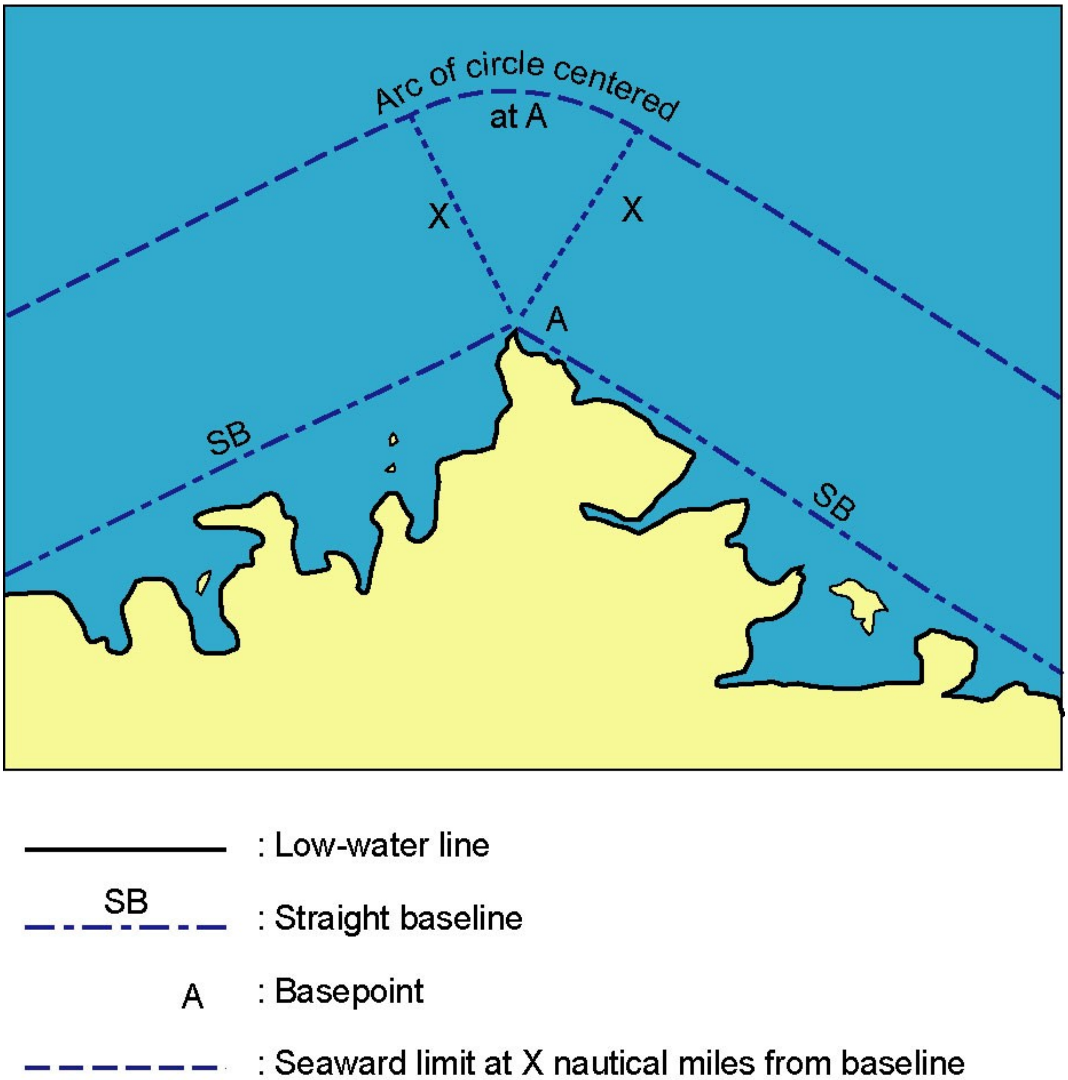


Figure 5.2 - In plane geometric terms, a limit at 12 nautical miles from a straight baseline consists of a straight line parallel to the baseline at a distance of 12 nautical miles. For a single base point, the limit consists of an arc of a circle with radius 12 nautical miles, centred on the point (diagram adapted from CARIS Training Manual).

5.3 TERRITORIAL SEA LIMITS

Since the breadth of the territorial sea is relatively narrow (the maximum allowable breadth is 12 nautical miles), sufficient accuracy might be obtained by plotting the limits directly on a chart. If the Mercator projection is being used, care must be taken to correct for the change in scale with latitude. This is particularly relevant to limits based on long straight baselines, especially if they are oriented north-south. The limit may not be a parallel line on the chart if there is a significant change in scale along the length of the line. In practice, it is advisable to use geodetic computation techniques in order to achieve an acceptable degree of accuracy.

In principle, the normal baseline can be described as an infinite number of points. The limit can be described as the envelope formed by a series of arcs of circles of radius x nautical miles centred on these baseline points (see Figure 5.3): Computer algorithms are available for implementing this approach.

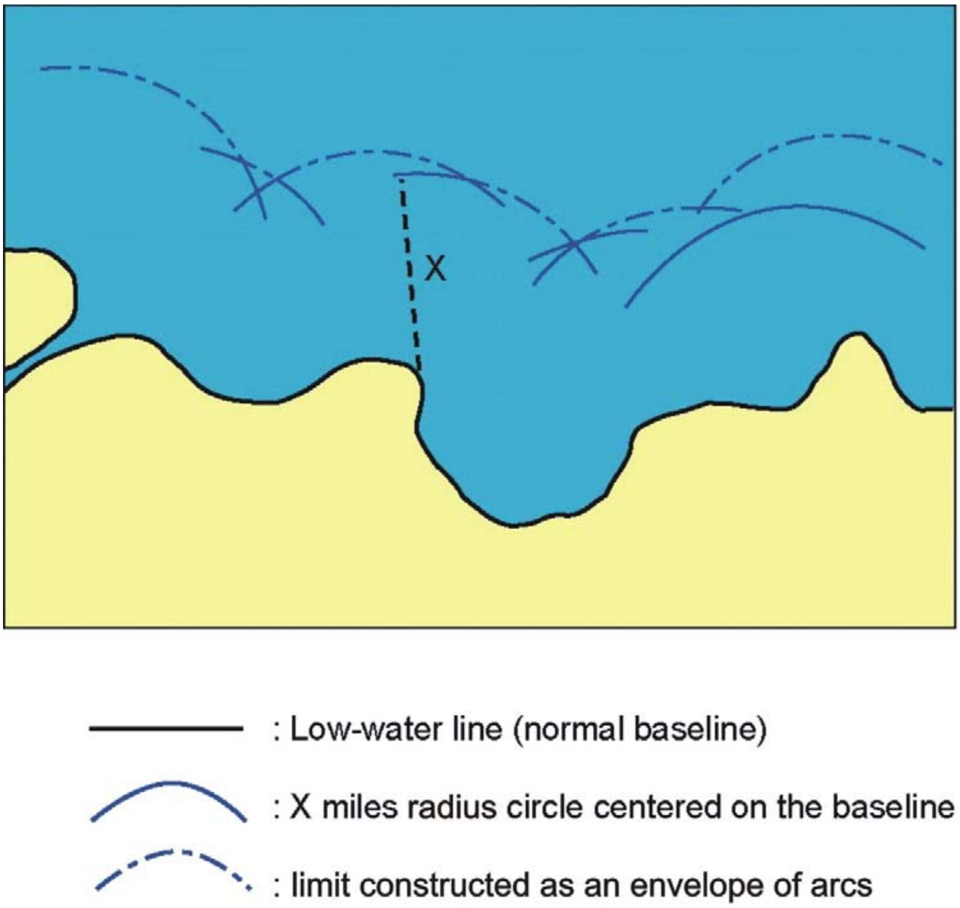


Figure 5.3 - The normal baseline can be described as an infinite number of points, but in practice only a few points may be needed for calculating a given limit. Such a limit can be described as the envelope formed by a series of arcs of circles centred on the selected baseline points, also known as base points (diagram adapted from CARIS Training Manual).

The limit of jurisdiction may also be visualized as the continuous line traced by the centre of a circle that has a radius of x nautical miles and which maintains contact with the baseline as it rolls along. (Figure 5.4)

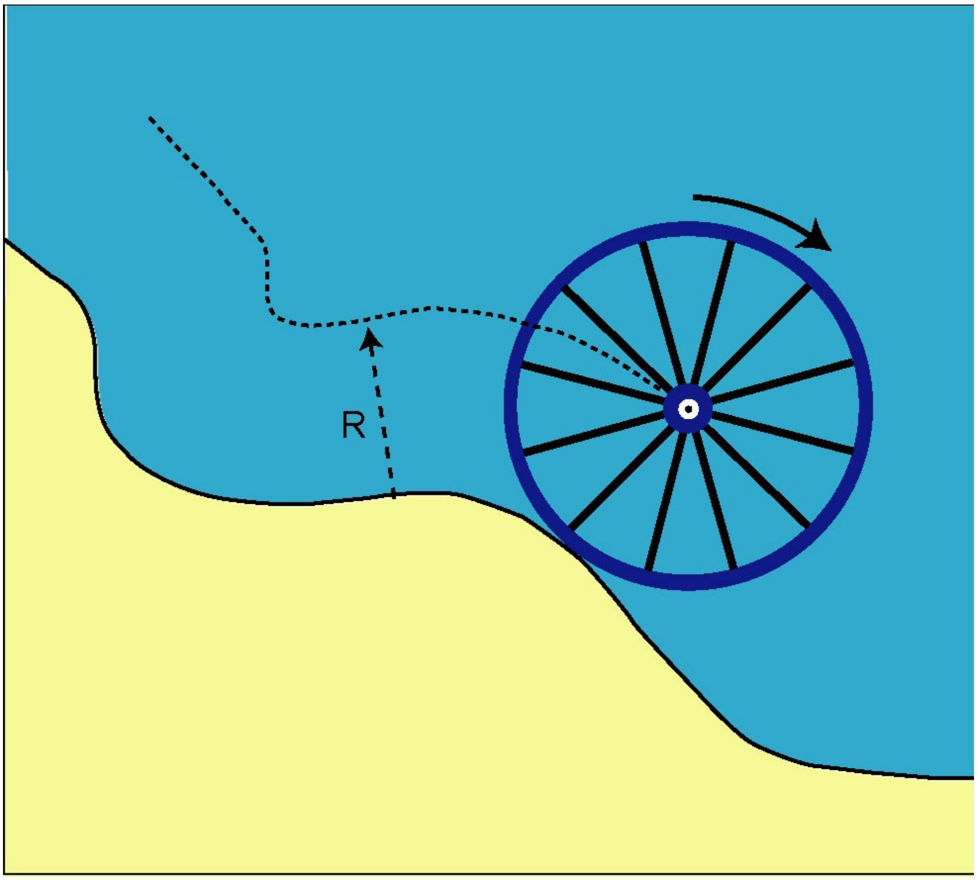


Figure 5.4 - A limit at a distance of R nautical miles may be visualized as the continuous line traced by the centre of a horizontal wagon wheel that has a radius of R nautical miles, and which maintains contact with the baseline as it rolls along the coastline

Note that the above descriptions satisfy the requirement that every point on the seaward limit should be at a distance of x nautical miles from the nearest point on the baseline (see Article 4). That requirement is not satisfied by the tracé parallèle, or replica line, which results from constructing a line identical in form to the baseline at a distance of x nautical miles from it on a perpendicular to its mean direction: in addition to being impractical in most situations, such a line fails to satisfy the LOS Convention.

5.4 GRAPHICAL CONSTRUCTION

Where straight baselines are involved and where the desired outer limit is near the coast, it is possible to rely on a method of graphical construction (although numerical techniques are preferable): A compass is set to the required outer limit distance. The point of the compass is then placed successively at suitably spaced locations along the baseline, and a short arc is drawn opposite each location. If the spacing of the locations along the baseline is reasonably close, a smooth outer limit will automatically be formed by the intersecting arcs (Figure 5.3).

Where the coast is indented, it may be possible to construct the arcs from the headlands forming the entrance to the indentation, and to ignore the coast that lies within. This will depend upon the geometry of the situation, i.e. the indentation will need to recede sufficiently that no point on its coastline can generate an arc that exceeds the arcs constructed from the headlands. (Note that we are not here considering indentations that are juridical bays as discussed in 4.2.2. In the same way, opposite a headland represented by a single base point, the limit may follow a single arc centred on the headland for a considerable distance before intersecting other arcs generated by neighbouring base points.

Whether constructing a limit graphically or numerically (the latter is advisable when x is large - say 200 nautical miles), the spacing of the points along the baseline is significant where the coast is straight or where it forms a smooth convex curve. The choice of spacing will represent a compromise between a ‘perfect’ outer limit and the level of effort that goes into its construction. With the advent of computer tools, this is no longer the problem that it used to be.

It can readily be verified that irregularities of the baseline will be reflected to some degree in the outer limit line if the latter has been correctly constructed. The greater the breadth of the zone to be measured from the baseline, the smoother will be the course of the outer limit, and the fewer will be the base points that affect its delineation.

5.5 COMPUTATION

Fully automated or semi-automated methods can be used for computing outer limits. With the possible exception of the territorial sea limits, sufficient accuracy for most requirements can only be obtained by computation.

A basic requirement for computing outer limits is to begin with a sequence of base point coordinates in digital form. In many cases, these coordinates will be tabulated in official documents published by the coastal state government, and they may be readily converted to digital form through keyboard entry. Where coordinates are not officially promulgated, for the sake of expediency they may be extracted from suitably-detailed charts using a digitizing table, or by visually determining the coordinates of the desired base points. The spacing and locations of these base points, and the care with which their coordinates are determined, will affect the accuracy of the outer limit. Chapter 4 discusses the principles of baseline construction.

When calculating outer limit coordinates, it is essential to use software that is capable of performing geodetic computations, to allow for variations arising from the curvature of the earth’s surface. Failure to do so can introduce non-negligible errors in the resulting outer limits.

5.6 EXCLUSIVE ECONOMIC ZONE (EEZ) LIMITS

"The exclusive economic zone limits shall not be extended beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured" (Article 57). The procedures to draw the limits of this zone are similar to those used to define those of the territorial sea, except that computational methods should be used in all final determinations.

5.7 CONTINENTAL SHELF LIMITS

The procedures for determining outer continental shelf limits are prescribed in Article 76 of UNCLOS. They are also elaborated upon in a number of publications, e.g. the Scientific and Technical Guidelines of the Commission on the Limits of the Continental Shelf (United Nations, 1999), and Continental Shelf Limits: the Scientific and Technical Interface (Edited by Cook and Carleton, 2000).

Determining the outer limit of the continental shelf where it extends beyond 200 nautical miles is more complicated and more difficult than constructing outer limits that are based solely upon distance from the Territorial Sea Baseline. Technically and in broad terms, the delimitation of the outer continental shelf is performed in two major steps: (1) determining the breadth of the continental margin through the application of formulas that are based on seafloor morphology and the thickness of underlying sediment; (2) deriving constraint lines that are based on bathymetry and distance from the territorial sea baseline, to prevent excessive encroachment of the continental margin onto portions of the seabed that underlie the high seas.

The following paragraphs offer a commentary and general advice concerning the interpretation of the Article, and the measurements that need to be made in order to establish the outer limit.

In many cases there will be very little detailed information available on either the bathymetry or the geology of the area of the continental margin beyond the geological continental shelf. Without such data it could prove difficult if not impossible to determine the outer limits of the continental margin with any accuracy. The work required to obtain such data is beyond the scope of this study: it requires the services of hydrographers and geologists, as well as vessels and equipment.

If those human and technical resources are available, then the expertise should also be available for interpreting the data and for determining the outer limits.

If it is decided to claim a continental shelf beyond 200 nautical miles, the collection and interpretation of the necessary data may involve significant cost and effort. For this reason, many States will begin by using information that is currently available to approximate these limits and to develop an understanding of the technicalities of Article 76. This will be followed by an analysis of data requirements, and by the formulation of a plan for acquiring new information in support of the State's case. This ensemble of preliminary investigation and assessment of data requirements is generally pursued within the framework of a <u>Desktop Study</u>.

The first procedure is to undertake a general examination of the topography of the seabed adjacent to the coastal State, with a view to identifying features that can be considered as 'natural components' of an extended continental margin. As much as possible, care must be taken to select components that will satisfy the criteria of Article 76, and in so doing to meet the requirements of the <u>Test of Appurtenance</u> as outlined in Section 2.2 of the Scientific and Technical Guidelines of the CLCS. It is entirely possible that inadequate data sets will introduce uncertainties in this selection process, in which case it will be necessary to re-visit the chosen components once new information is in hand, and to justify their classification as components of the continental margin.

Early in the implementation process, a decision will be required concerning methods for managing and archiving geo-referenced data sets in digital form; this could entail the use of a commercial database package, in which case it would be best to seek expert advice on the selection of the most appropriate software. Then it will be necessary to choose or to design a suitable cartographic base (which we may call the working chart) for displaying the different parameters involved in the implementation of Article 76. This may consist of a conventional paper plotting sheet, but it is usually preferable to use a custom digital map that has been created by a Geographic Information System (GIS), and which covers the entire study area.

A digital map has several advantages over a paper sheet: (a) it can be readily constructed from the contents of a digital data base; (b) it can be displayed at any scale; (c) it is easy to revise as new information becomes available; (d) its contents can be readily correlated or co-displayed with complementary data sets; and (e) it can be printed on paper with considerable flexibility as to size and format.

Whether in paper or digital form, the working chart should provide a convenient means of displaying the following parameters at a common scale and projection, as they become available during the life of the project:

a) the 200 nautical mile limit

b) bilateral boundaries with neighbouring States

c) distribution of available data sets (bathymetry, seismic reflection, etc)

d) the foot of the continental slope

e) the 2500 metre isobath

f) Formula Lines:

   i. the 'Gardiner Line', i.e. the location of the line where the thickness of sedimentary material is equal to 1% of the distance back to the foot of the continental slope, Article 76.4 (a) (i);
   ii. the 'Hedberg Line', i.e. the foot of the continental slope projected seaward by 60 nautical miles, Article 76.4 (a) (ii);

g) Constraint Lines:

   i. the 2500 metre isobath projected seaward by 100 nautical miles, (Article 76.5);
   ii. the 350 nautical mile limit, measured from the territorial sea baseline.

h) the final outer limit, usually a combination of Formula and Constraint Lines, and approximated by a succession of straight line segments (geodesics) not exceeding 60 nautical miles in length.

5.7.1 Data Sources

Many data sets already exist that are suitable for use in desktop studies, and they may be obtained in digital form from a variety of sources. An overview of data centres, and of the public-domain data sets dispensed by them, is contained in Chapter 15 of Cook and Carleton (2000). The Scientific and Technical Guidelines (CLCS, 1999) provide additional advice concerning the admissibility of data sets, as well as the requirements that govern their presentation to the Commission.

Nautical charts do not usually show sufficient isobaths (depth contours) to be useful for determining the position of the foot of the continental slope, nor do they show sediment thickness. For both these purposes, and to trace the 2500 metre isobath, more informative documents are needed that portray bathymetry and sediment distribution at a suitable scale. The General Bathymetric Chart of the Oceans (GEBCO), which is available from the International Hydrographic Bureau, gives world coverage of bathymetry on the Mercator projection between the equator and latitude 70N/S approximately, at a scale of l:10,000,000 (about 0.185 mm to a nautical mile) at the Equator. (At 70N/S latitude the scale is about 1:3,500,000, or 0.53 mm to the nautical mile). The polar areas (above 65N/S latitude) are shown on a Polar Stereographic projection at a scale of 1:6,000,000. Small-scale charts showing sediment thicknesses in the major oceans have been published in scientific journals and oceanographic atlases.

While it is possible to obtain a reasonable idea of the limits of the continental shelf using data displayed on paper documents, it will usually be easier and often more reliable to use data sets in digital form. For example, the GEBCO Digital Atlas (BODC, 2003) describes the depth of the world ocean in two ways: as vectors that represent depth contours (generally at depths of 200m, 500m, and at 500m intervals thereafter), and as a grid of depth values spaced at intervals of one minute of latitude by one minute of longitude. The US National Geophysical Data Center (NGDC) offers a generalized five-minute by five-minute grid of total sediment thickness for the world’s oceans and marginal seas. Users are cautioned that global data sets such as these may be based on very general information in some places, with considerable extrapolation from sparse data. Therefore it is desirable to find more detailed data if possible. If local sources cannot provide the material, large oceanographic institutes will usually be aware of what published work is available, and often what projects are in hand. Application to them may produce better data, or advice on where it may be obtained.

Whatever the source of bathymetric and sedimentary data, it will be helpful to incorporate the information in a digital database and to add it to the digital working chart as a layer that can be displayed on demand for easy correlation with other parameters and data sets.

It is necessary to consider not only the continental shelf that extends from the mainland, but also the continental shelf of an island of that State which is entitled to its own continental shelf (see Article 121.2).

5.7.2 The Foot of the Slope

Article 76 defines the foot of the slope (FOS), in the absence of evidence to the contrary, as the point of maximum change of gradient at the base of the continental slope. The CLCS Guidelines devote two chapters to this topic: Chapter Five discusses the determination of the

FOS as the point of maximum change of gradient; Chapter Six addresses the determination of the FOS by means of evidence to the contrary. Each chapter considers the applicable methodologies and criteria, and outlines requirements to ensure the acceptability of data and evidence. It is worth noting that use of the maximum change of gradient is considered as a general rule, and that evidence to the contrary is viewed as an exception to that general rule.

The general locality of the line of maximum change of gradient may be found from inspection of the bathymetric map. However, this approach is unacceptable to the CLCS (Section 5.4.7 of the Guidelines), and a more precise localization will require an examination of a series of transverse bathymetric profiles obtained either directly from surveys, or extracted from a compilation product such as a bathymetric map or a digital bathymetric model. Selected profiles should be at right angles to the general direction of the continental slope in the immediate vicinity of the line, at intervals that will form a suitable reference line from which to measure the outer limit, whether by sediment thickness or by a 60 nautical mile distance limit. The main salients of the slope should be included.

If the FOS is to be determined through a visual inspection of profiles, these should be constructed with their vertical scales exaggerated sufficiently to show clearly the changes of gradient. If the profiles are recorded in digital form, specialized software is available to facilitate the determination of the maximum change of gradient by deriving and displaying the second derivative of the profile; in most cases, this procedure creates a curve with several identifiable maxima that represent the locations of local changes of gradient. The operator may then select the location that appears most appropriate. In the situation where two or more FOS points seem acceptable, the CLCS Guidelines (Sections 5.4.5 and 5.4.12) would seem to indicate that the seaward-most point can be selected, as long as suitable justification is provided for that particular choice.

Clearly, depth observations that are used for this purpose must be positioned to a high level of accuracy, but it is worth noting that the depths themselves need not be measured to a comparable level of accuracy because locating the change of gradient requires an analysis of relative changes of depth, and not absolute depths

The necessary number of points having been determined, their locations can be entered in the data base and connected to define the FOS. At this stage, they may also be displayed in printed or digital form.

5.7.3 The 1% Sediment Thickness Formula

The parameter derived according to this formula is sometimes referred to as the Gardiner Line. Its position is determined by a succession of points where the thickness of sedimentary rock is at least 1 percent of the shortest distance from each point to the foot of the slope (Article 76.4 (a) (i)). The principle is illustrated in Figure 5.5, which portrays an ideal situation that is unlikely to be reflected in the real world.

Chapter 8 of the CLCS Guidelines consists of explanations and elaborations concerning the application of the sediment formula. It describes the techniques involved, and it discusses the problems that arise in attempts to reconcile real-world observations with the ideal sediment model that underlies the formula’s assumptions. The 1% line is most easily derived through the use of available software that displays the sediment thickness overlain by a line that represents the location of the foot of the slope. Lines are constructed to seaward from the foot of the slope and perpendicular to it. These should be situated at intervals such that the outer ends are not more than 60 nautical miles apart, and that they adequately cover the areas where the thicker sediments are situated.

A profile of sediment thickness along each line is then plotted. On the profile graph a 1% line is also plotted from the zero of the graph, which represents the intersection of the foot of the slope and the surface of the sedimentary rock (see Figure 5.6).

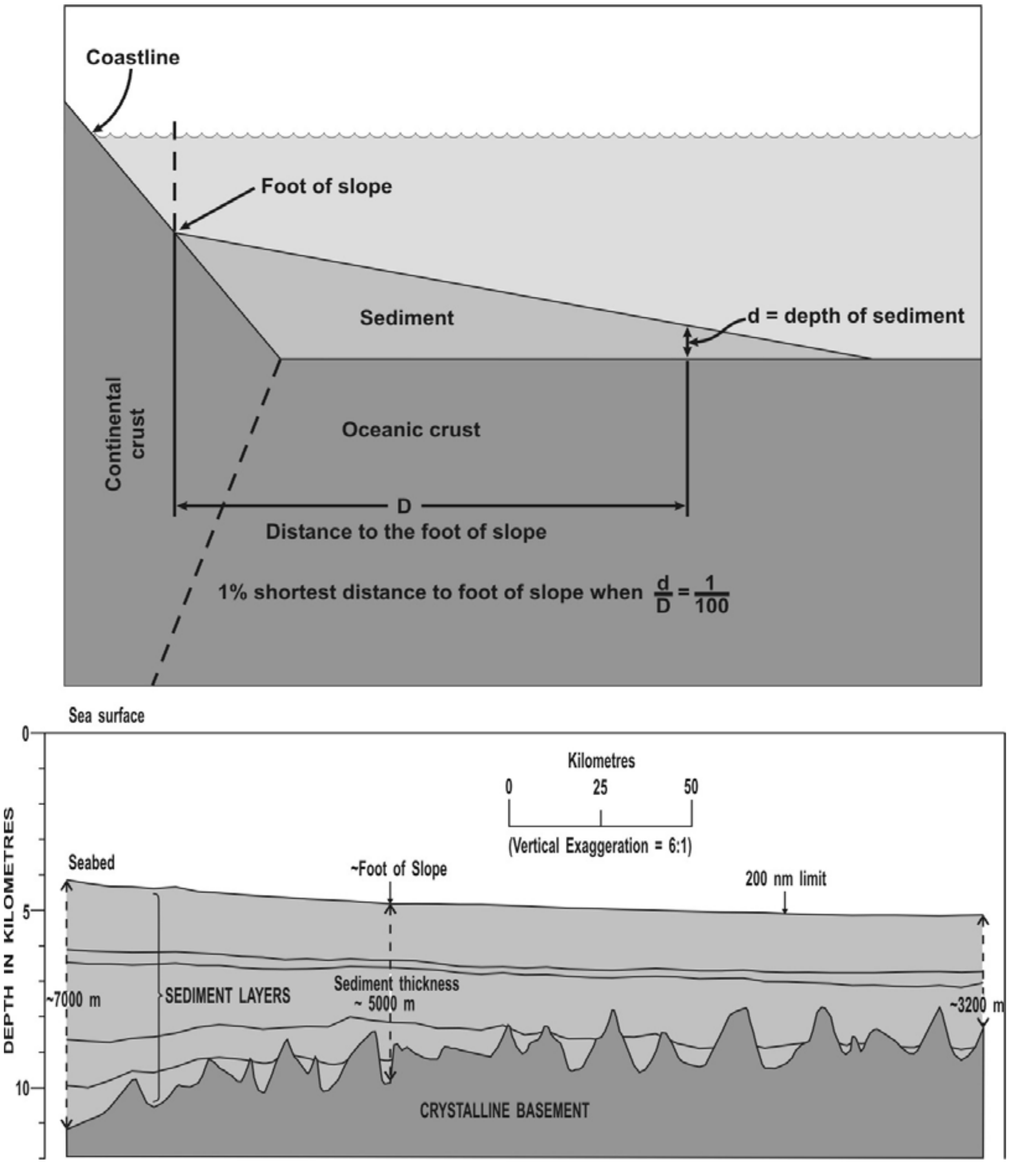


Figure 5.5 - The sediment thickness formula of Article 76, in principle and in practice: the upper diagram presents the simple model upon which the formula is based; the lower diagram presents a typical sediment profile off the Canadian Atlantic margin (courtesy C.E. Keen, Geological Survey of Canada), where the ruggedness of the crystalline basement contrasts with the smooth oceanic crust of the conceptual model.

The 1% line is constructed so that at any point the reading of the vertical scale (of sediment thickness) is 1/100th the reading of the horizontal scale (of distance from foot of slope). The point of intersection of that line with the profile of sediment thickness is the required point, and the distance from the foot of the slope may be read off the graph. Whether using a graphical or a computer technique, the vertical scale should be sufficiently exaggerated to ensure that the angle of intersection of the l% line with the sediment profile is wide enough to permit the distance to be read off without too much uncertainty. Each point so determined should be plotted on the working chart.

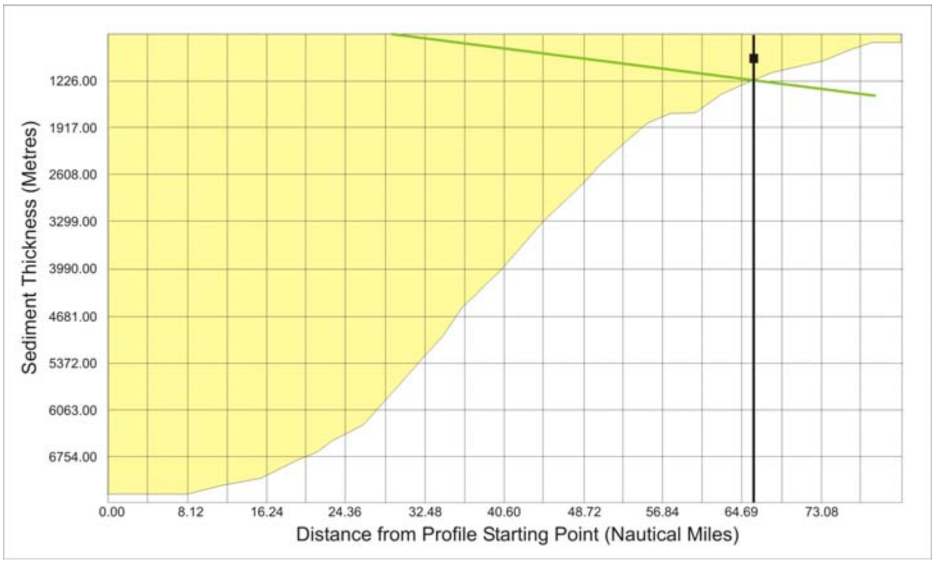


Figure 5.6 - This illustrates the determination of the point where the thickness of sedimentary material is equal to 1% of the distance back to the foot of the slope. The coloured portion of the plot represents a profile of sediment thickness (the top 500 metres or so are not shown). The profile starting point (0.00 nautical miles) is positioned at the foot of the slope. The green line intersects the base of sediment at the location where the sediment thickness (1226.0 metres) equals 1% of the distance to the foot of slope (66.2 nautical miles).

5.7.4 The Distance Formula

The parameter derived according to this formula is sometimes referred to as the Hedberg Line Its position is determined by a succession of points that are located no more than 60 nautical miles seaward of the foot of the slope. It is possible to construct this feature using graphical techniques; however for the sake of accuracy it is strongly recommended that geodetic software be used to compute the geographic coordinates of the determining points. These points, along with the line that they define, should be added to the working chart.

5.7.5 The 350 Nautical Mile Constraint Line

This is the first of two constraint lines that are applied to prevent excessive encroachment of a State's extended continental shelf into the high seas zone. It is best determined by using geodetic computations to develop an envelope of arcs that have a radius of 350 nautical miles and which are centred on the territorial sea baseline. The line so determined should be added to the working chart.

5.7.6 The 2500 Metre Plus 100 Nautical Mile Constraint Line

This is the second constraint line. Its position is determined by a succession of points that are located no more than 100 nautical miles seaward of the 2500 metre isobath. The coordinates of these defining points are best computed by using geodetic software. Chapter 4 of the CLCS Guidelines reviews the issues involved in determining the location of the 2500 metre isobath. Unlike the foot of the slope, absolute depths are required for this purpose, therefore these observations need to be acquired with high levels of vertical, in addition to horizontal, accuracy. Also, ambiguities can arise when more than one 2500 isobath is encountered: in this case and barring evidence to the contrary, the CLCS may recommend the use of the 2500 metre isobath that is nearest the territorial sea baseline. The line so determined should be added to the working chart.

5.7.7 The Limit of the Continental Shelf

Depending on the specific situation, the working chart should portray the formula lines (Gardiner and Hedberg) either partially or in their entirety. The outer limit of the continental margin may now be constructed by selecting and the outlying segments of the formula lines and by combining them into a single line (Figure 5.7).

The working chart should also display the constraint lines (350 nautical miles, 2500 metres plus 100 nautical miles) either partially or in their entirety. In general, the outermost components of each line are then selected and merged to construct a combined constraint line (Figure 5.8). According to Section 6 of Article 76, this procedure applies to submarine elevations that are natural components of the continental shelf, but not to submarine (oceanic or spreading) ridges, where only the 350 nautical mile constraint can apply.

Under most circumstances, the outer limit of the continental shelf will be constructed by merging the outer limit of the continental margin (which may be a combination of the formula lines) with the combined constraint line. Where the continental margin lies inside of the combined constraint line, the former's outer limit will define the outer limit of the continental shelf; where it extends beyond the combined constraint line, the latter will truncate the former and become the outer limit of the continental shelf.

The actual outer limit of the continental shelf will be formally defined by a succession of points joined by straight lines that are no more than 60 nautical miles long. These points may be arbitrarily selected, although they will normally be chosen to maximize the enclosed shelf area. Once selected, their geographical coordinates must be expressed in a specified geodetic datum. (Figure 5.9)

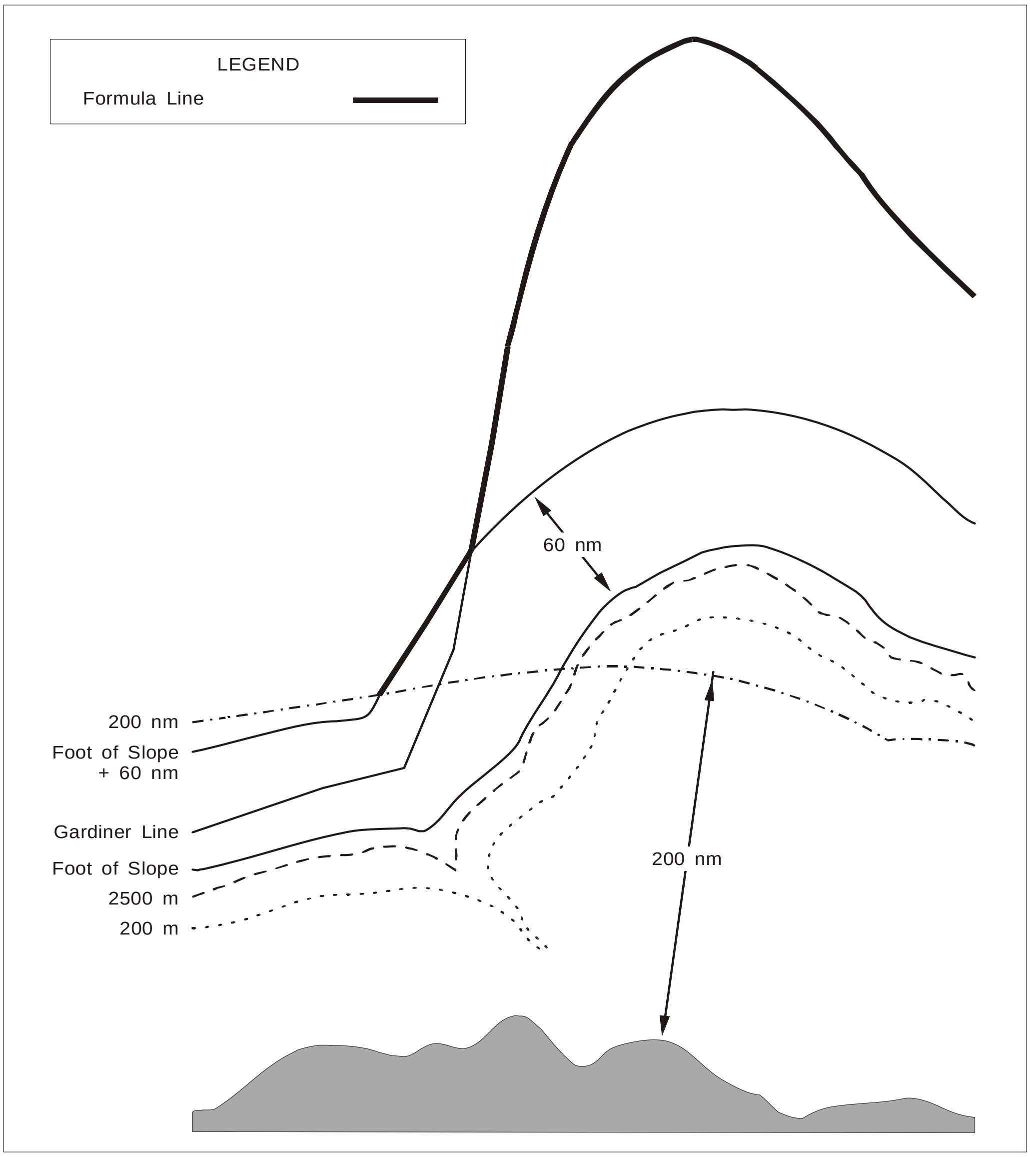


Figure 5.7 - The outer limit of the continental margin is defined by selecting and combining into one line the outlying segments of the two formula lines: the Foot of Slope projected seaward by 60 nautical miles, and the line of 1% sediment thickness (also known as the Gardiner Line). Diagram is not drawn to scale.

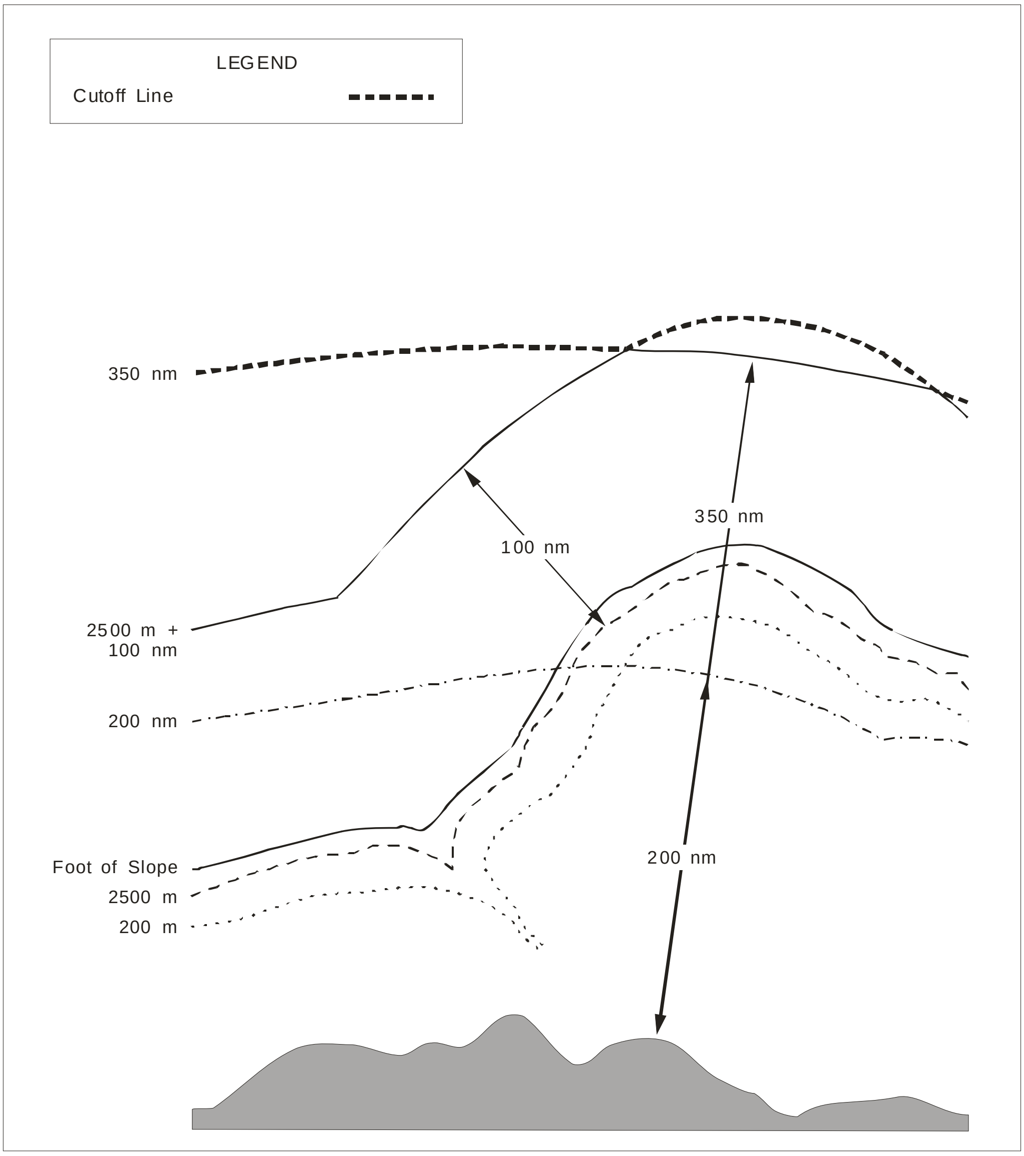


Figure 5.8 - The cut-off line combines into one line the outlying segments of the two constraint lines: the 350 nautical mile limit and the 2500 metre isobath projected seaward by 100 nautical miles. Diagram is not drawn to scale.

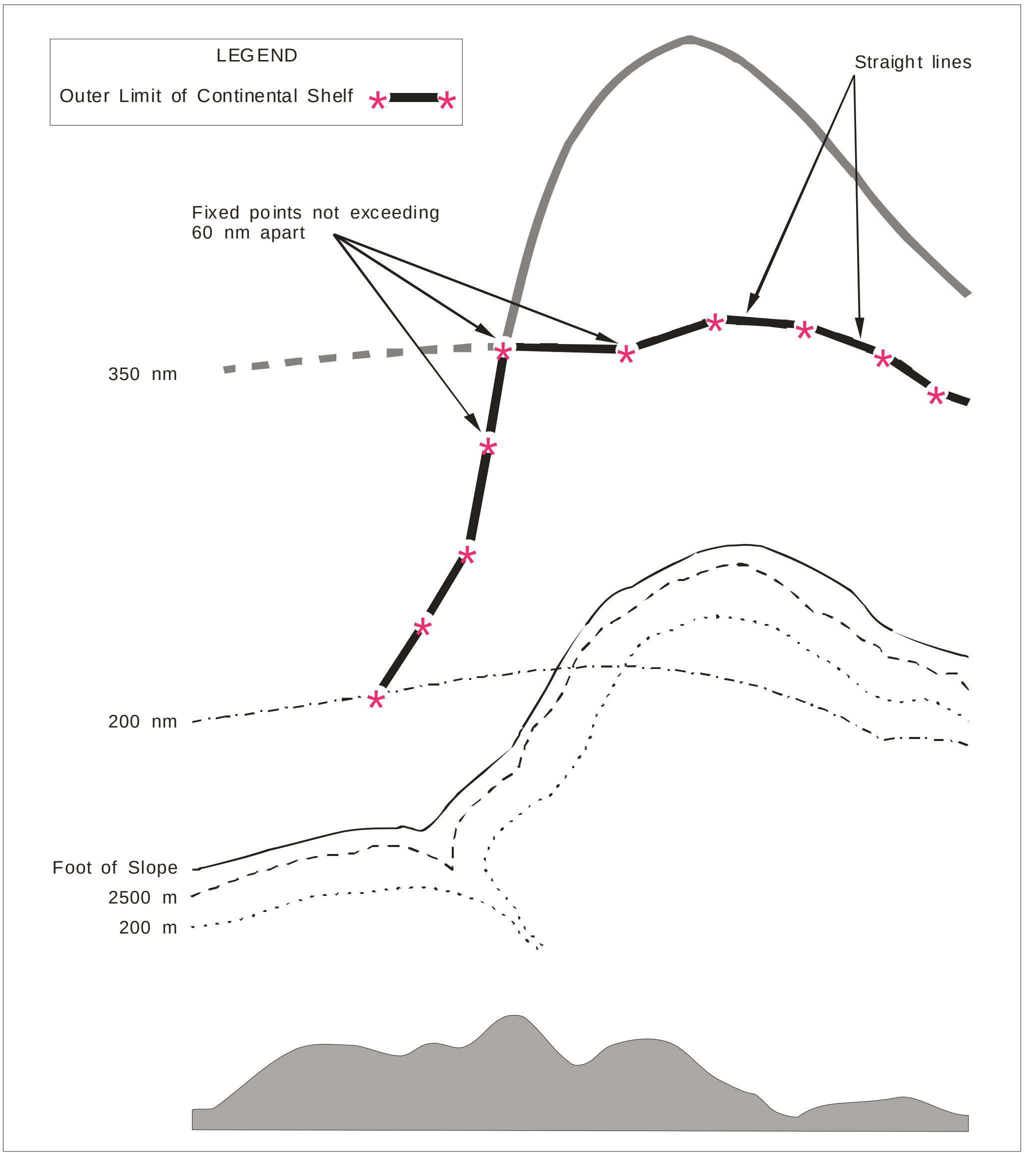


Figure 5.9 –The outer limit of the continental shelf is constructed by merging the outer limit of the continental margin (Figure 5.7) with the combined constraint line (Figure 5.8). Where the continental margin lies within the combined constraint line, the former will define the outer limit of the continental shelf; where it extends beyond the combined constraint line, the latter will truncate the former and become the outer limit of the continental shelf. The actual limit of the continental shelf is formally defined by a succession of points joined by straight lines that are no more than 60 nautical miles long. Diagram is not drawn to scale.

5.7.8 Data Gathering Operations

When the outer limit of the continental shelf extends beyond 200 nautical miles, it will likely be necessary to collect new, geographically-referenced data in order to substantiate the coastal State's claim. For the most part, this will consist of measurements of water depth and sediment thickness, although there may be situations where complementary observations of the local gravity and geomagnetic fields could prove useful as 'evidence to the contrary'. Under some circumstances, bottom sampling may be necessary to establish the nature of material on or beneath the seabed. Regardless of its class or the means of its collection, new information must adhere to high standards of accuracy, with due care given not only to the acquisition process, but to the determination of positions within a known geographic frame of reference.

Existing bathymetric maps are often inadequate for determining the location of the foot of the slope or of the 2500 metre isobath, thus necessitating the design and execution of special survey operations to supplement the available information. Survey techniques and patterns will vary according to circumstances, and will usually reflect a compromise between the cost of the operation and the extent of data coverage. For instance, the location of the foot of slope is derived from an analysis of relative changes of depth, and does not require observations of absolute bathymetry. Therefore, soundings collected for this purpose may be acquired to a less stringent standard than soundings collected for determining the location of the 2500 metre isobath, which is derived from absolute depths to which all appropriate corrections have been applied.

Beneath the deeper waters applicable to Article 76, the nature and distribution of the sedimentary material tend to be poorly known, and in many cases it will be necessary to acquire new data for the implementation of the 1% sediment thickness formula. Techniques for measuring and analyzing sediment thickness range widely in cost, complexity, and effectiveness. Consequently, the design, implementation and interpretation of a seismic acquisition program are best left to qualified experts who can provide specialized advice and assistance. Additional geophysical observations such as measurements of the earth's magnetic and gravity fields may contribute to an improved interpretation of the seismic data.

Current navigation technology is adequate for determining accurately the locations of data and sampling points. However it is essential to ensure compatibility between the reference datums used by the positioning system and by those used to describe the parameters that are integral to the construction of the outer continental shelf limit: the territorial sea baseline, bathymetry, sediment thickness, the foot of slope, and the 2500 metre isobath.

CHAPTER 6 - BILATERAL BOUNDARIES

TABLE OF CONTENTS

6.1 GENERAL

Neighbouring States may be opposite or adjacent. In this chapter it is assumed that in the case of adjacent States, the coastal terminal point of the land boundary is agreed or that, if the boundary terminates at the seaward limit of internal waters, the terminal point is agreed.

It is also assumed that there is no dispute about the baseline claims.

Article 15 specifies that neither of these States is entitled, failing agreement to the contrary, to extend their territorial seas beyond the equidistance line between them. But this provision is inapplicable if historic title or other special circumstances make it necessary to use another method.

The legal provisions of Articles 74 and 83 which are identical, pertain to the delimitation of the boundaries of Exclusive Economic Zones and Continental Shelves respectively.

Unfortunately for the technical expert engaged on maritime delimitation, an equitable solution has no objective meaning, and there are many possible ways in which an equitable solution may be approached. In any particular case, though, the approach to the problem may well follow a well-known method which is departed from in the last stages in order to achieve the required result. It is not intended here to consider all the possible ways in which solutions may be reached, but to mention only a few basic techniques on which the expert charged with the technical work may build.

Before examining the different concepts, there are three technical considerations to be borne in mind:

An appreciation of the appropriate accuracy and precision obtainable or to be achieved is as important in bilateral delimitation as in the determination of baselines or unilateral limits.

Where a dense selection of base points has been used to arrive at the course of an acceptable boundary, the resulting line may be too complex for description in a treaty or for administration. Some form of simplification may then be necessary.

It is possible, but may be inconvenient, to have bilateral boundaries which do not form a continuous division of maritime jurisdiction between States. In order to prevent "gaps" from existing between opposite or adjacent States, it is desirable to have a continuous line that separates all types of maritime jurisdiction (e.g. territorial sea, EEZ and continental shelf).

6.2 THE EQUIDISTANCE METHOD

In maritime boundary delimitation an equidistance line is defined as a line every point of which is equidistant from the nearest points on the territorial sea baselines of two States. Article 15 refers to this line as a median line, but in the technical literature a distinction has often been made between a median line, defined as an equidistance line between two opposite States, and a lateral (equidistance) line, which is defined as an equidistance line between two adjacent States (see Appendix 1). In practice, however, the concept of adjacent and opposition are often difficult to define and apply, but the method used to determine an equidistance line is the same whatever the relationship of the coasts of the States.

The equidistance method of constructing bilateral limits is a useful start to the technical process of delimitation because:

a) it is the method that must be employed in the territorial sea in the absence of agreement or special circumstances;

b) it is a well defined geometric method which is relatively easy to apply, particularly using modern computer methods (if the baselines are clearly defined) and gives a unique line.

When discussing this method all explanations will be given as if calculations and measurements are made on the plane. Of course in practice they are made on the ellipsoid and the plane geometrical terms used are not necessarily absolutely correct for the ellipsoid. For instance, the locus of the points comprising a line equidistant from a single basepoint of one State, and a straight baseline (geodesic) of another, is here referred to as a parabola. In fact it is a more complex curve and is not even the intersection between a paraboloid and the ellipsoid as this would be true of chord distances rather than those on the surface of the ellipsoid.

Finally, an equidistance line generated by two single basepoints is a unique line that is very nearly but not exactly coincident with a geodesic. In practice, however, it is considered to be the same as the geodesic between the successive turning points.

6.2.1 The Construction of the Equidistance Line

An equidistance line has already been defined above. Figure 6.1 illustrates graphically the construction of an equidistance line between opposite States (a) and one between adjacent States (b).

Figure 6.1 (a) shows the coasts (the low-water line) of two opposite States, both of which employ normal baselines (i.e. not a system of straight baselines). The construction of the median line may be seen on the left hand side of the figure. Taking points **a** and **b**, a perpendicular bisector is drawn **op** with **m** being the precise bisecting point of the line **ab**. Proceed towards **p** until a point **c** of State **A** now becomes equidistant from a mid point **q** to **a**, **b** and **c**. Now taking **b** and **c** a perpendicular bisector **o'p'** is drawn. This intersects the first baseline bisector **op** at **q**. Then proceed towards **p'** until a point **d** in State **B** becomes equidistant from a midpoint **r** to **b**, **c** and **d**. By continuing to proceed to the right in this way the segments of the median line will be constructed until the total median line is derived. The points along the median line equidistant from three points are known as tri-points.

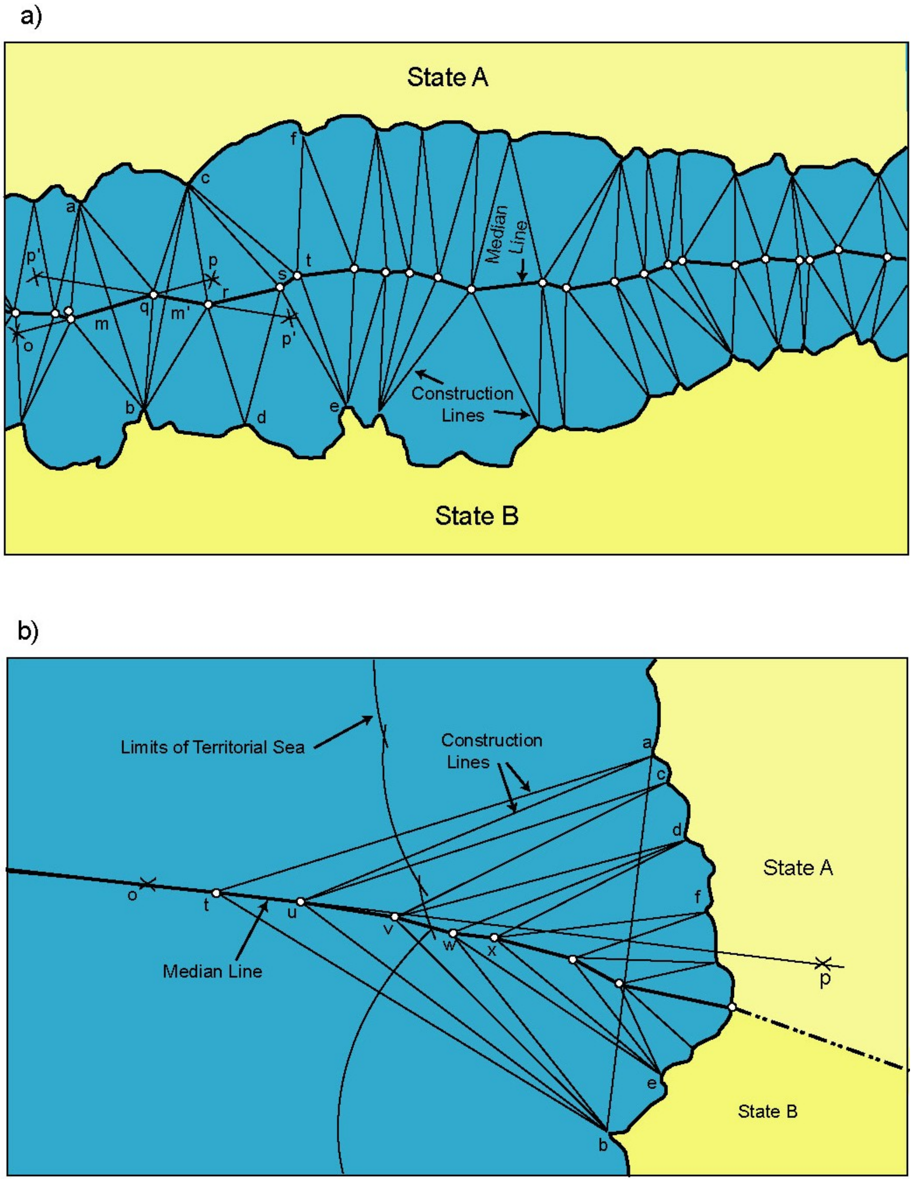


Figure 6.1 - The Equidistance Line

Figure 6.1 (b) shows the coasts (low-water line) of two adjacent States, again, both of which employ normal baselines. There is no essential difference between the method of determining the equidistance line in this case and that already described for opposite coasts. Difficulties in determining the link with the land boundary may, however, be avoided by beginning the exercise from seaward rather than from the land boundary terminal. The construction of this equidistance (lateral) line may be achieved as follows:- Starting a suitable distance offshore look for two points, in this case **a** and **b**, situated in States **A** and **B** respectively, that are an equal distance from starting point **t**. Produce the angular bisector **op**. Proceed shoreward until at point **u** it is found that an additional point **c** is equidistant with **a** and **b**. Now prescribe the angular bisector between **b** and **c** and again continue shoreward until point **v** is reached where a new point **d** is equidistant to **c** and **b**. Continue the process and it will be found that the equidistance line terminates at the land boundary between States **A** and **B**.

Equidistance between straight baselines: If the two countries decide to use their straight baselines instead of their normal baselines (low-water line), as some pairs of countries have, then the equidistance line develops into segments of equidistance between:

a) two points which is a straight line,
b) two lines which is a straight line, and
c) a line and a point which is a section of a parabola.

(All these examples are using plane geometry terminology).

6.2.2 Selecting Basepoints

Only portions of a State's baseline will affect an equidistance line. By definition, the equidistance line will be constructed by using only the salient (seaward-most) basepoints. The number actually chosen will depend on the interplay of the relevant segments of baseline of both States, on the configuration of the coastline, and on the distance of the median line from the nearest basepoints. The greater the distance, the fewer the basepoints that are likely to affect it, and the greater the distance that may be selected between points along a smooth coast.

6.2.3 Graphical Method of Constructing an Equidistance Line

The construction of an equidistance line using a combination of pure graphical methods and the computation of the turning points requires considerable expertise and can be very time consuming. If this method is used it will probably only achieve an approximate result, which may not be acceptable as a final solution.

A first step in the delimitation process will be to examine the largest scale nautical chart in detail to decide which points and Sections of the coast may be legitimately used in the delimitation. Decisions must be made on such matters as whether features are low tide elevations or islands, or whether an island has a lighthouse or other navigational aid on it and may therefore be used as a point in a straight baseline system. The coordinates must be derived from and plotted on, as the case may be, the largest scale chart.

It is neither practicable nor necessary, to select more than a certain number of these basepoints in order to determine the course of the equidistance line. Graphical methods provide the simplest way of selecting (at least initially) the basepoints. This requires selection of a suitable chart which shows enough of the baselines of both States (at a scale large enough to see small islands and low-tide elevations), and enough of the water area through which the relevant section of median line will run, to enable a reasonable number of basepoints to be selected before moving on to the next chart.

It should be noted that all basepoints that affect the calculation should be on the same datum (see Chapter 2).

The possible basepoints having been identified, their geographical coordinates must be listed, together with the sequence in which they affect the line. The coordinates should be taken off charts of large enough scale to achieve the desired accuracy. This is likely to be a larger scale than that used for identifying them in the first place. The larger scale is likely to reveal that what seemed to be a single point is now seen to be a feature where more than one point might affect the line. Experience will suggest several ways in which this may be resolved, but if necessary all the coordinates should be read off. Similarly, when selecting basepoints on the small scale general chart it may be unclear which of two or more features really affects the line, or new points on both baselines may appear to become equidistant at the same time. If the problem cannot be resolved by inspection their coordinates should also be listed.

The further resolution of these problems must await the computation process, when accurate distance checks must be made from points on the equidistance line to discover whether other listed basepoints are closer than those being used.

6.2.4 Automated Calculation of an Equidistance Line

The generation of an equidistance line using the tools provided in modern GIS systems is the preferred method. It should always be remembered that these systems are only as good as the data that is imported to them. It is also important to ensure that the GIS system used carries out all these calculations on the ellipsoid. All the data that is imported into the system for the calculation must be on the same geodetic datum.

In order for the system to select the relevant basepoints for the calculation of the equidistance line, the low-water line of both relevant coastlines must be digitized. The baseline may be made up of normal baseline segments, including bay closing lines and river closing lines, straight baselines, and/or archipelagic baselines. Each of these "straight line" segments must be split up into short sections. A decision must be made to define the intermediate points for each of these straight line segments for use in the calculation.

As an example the process of one commonly used GIS system is as follows: The low-water line is digitized from the latest edition of the largest scale chart of the area. If other coastline models are used there will be a danger that they will not depict the best low-water line available. The bay closing lines and river closing lines are defined by creating a text file, or logical list of the bay closing line or river closing line terminal point co-ordinates. Similarly the turning point co-ordinates of straight baseline systems and/or archipelagic baseline systems are entered as text files or other logical list from the original national legislation. This data is then joined to form two sets of vector line data. It is from this data that the software will calculate the equidistance line. A report will be generated for each turning point on the line defining the co-ordinates of the point and the three baseline points from which it has been generated. At this point it is probable that there will be many more turning points generated that are either practical or needed to accurately define the line. This line will then have to be simplified.

6.2.5 The Simplified Equidistance Line

The equidistance line is composed of a finite, but often large, number of turning points joined by geodesics (see Section 3.9.1.) or other curves. Very often this produces too complex a line for easy description or practical application, and simplification is needed.

A simplified equidistance line should consist of the smallest practicable number of elements which still maintain the general course of the original line. The turning points should all be linked by 'straight lines', which may be either loxodromes or preferably should be geodesics as considered most suitable for practical application.

Ideally, a line should be simplified so that the resulting course of the line remains the same as the original line, or deviates so little that the resulting area gained or lost by the States is essentially zero. Under any simplification process this area should be calculated as, with other factors, it may affect the decisions in the boundary negotiations.

It is possible to arrive at other simplified lines, where other more or less objective considerations are taken into account to achieve an equitable result. In particular it is possible to take into account only the most prominent basepoints, so that the resulting equidistant line is necessarily less complex than the strict line would be. Whilst these solutions undoubtedly produce a line that is simpler than a strict equidistance line, they are not derived directly from it; neither do they maintain the close relationship with it that is achieved with the "simplified equidistance line" already described. These other lines are sometimes referred to as "modified equidistance lines".

6.3 METHODS DERIVED FROM THE EQUIDISTANCE PRINCIPLE

6.3.1 Partial Effect

It may happen that an equidistance line would produce an equitable delimitation except for the effect of some particular baseline feature. Typically such a feature might be situated where it has a disproportionate effect on the course of the line. This distortion may be corrected by assigning such a feature no effect at all, or only partial effect, in the delimitation. In theory the effect to be given may be in any desired ratio, but in practice if partial effect is to be given it is often in the form of half-effect.

The half effect line lies half way between the full effect line and the no-effect line; such as, a parallel line half way between two parallel lines, the angle bisector, or more generally, the locus of points equidistant from the closest point on both the full effect and no-effect lines. Note that this half-effect line may not equally divide the surface area between the full and no-effect lines, and there has been no suggestion that it should do so.

The most familiar method of application is to construct two equidistance lines: one uses the feature as a basepoint, thus giving it full effect: the other ignores the feature, thus giving it no effect. The half-effect line lies half way between the full-effect line and the no-effect line.

In the case just cited, it might be supposed that the correct method would be to select an imaginary, or notional, basepoint located as though the island were only half as far from the mainland as it really is. The geometry is such, however, that an equidistance line, constructed by substituting the notional basepoint for the real feature, would be unlikely to coincide with a half-effect line obtained by the preceding method. Very often the relationship of the distorting feature to the basepoints controlling a no-effect line will be such as to make it difficult to decide upon a suitable position for the notional basepoint.

There will be occasions when the full - and no-effect lines will be rather complex. That may make construction of a half-effect line in the manner previously described undesirably complicated. In such a case agreement on a notional basepoint might provide an easier solution.

6.3.2 Coastal Length Comparison

The first step is to ascertain **r**elevant parts of the coast, then to measure or to calculate the total length of the coast. Several methods may be used, depending on agreement between the Parties.

i) The coastline on a map or chart of chosen scale may be "completed" by drawing closing lines across rivers, and bays, and the total length measured. This length may be measured by digitizing and then calculating the length by computer or in the absence of such technology, measured by a curvometer.

ii) The coast is represented by a finite set of discrete points linked by mathematically defined lines (as geodesics, for example). The density of the points will depend upon the required accuracy and the regularity of the coastline. The sum of the length of the linking lines is the total length.

iii) More commonly the coast is represented by a series of straight lines following the lines of general direction taken by the real coastline, and the lengths of the separate sections of generalized coast are summed. This may take two forms: either the lines of general direction reflect only the direction of the coast that 'faces' the area of delimitation, ignoring indentations etc., or it includes the major indentations but represents their outline by generalized lines. The extreme case of lines of general direction occurs when the whole coast is represented by a single line. This may be done where the whole coastline of the State is a more or less straight line with only relatively minor indentations or by agreement by the Parties.

If there is a marked difference in coastal lengths between the two States there may be a requirement to move the median line towards the shorter coast in order to achieve an equitable result.

If the two States can agree on the relevant area to be delimited it is possible to divide this area in a similar ratio as the coastal fronts. Modern GIS systems are capable of calculating areas on the ellipsoid with considerable accuracy (see Section 2.7). This can achieve an equitable result in some cases, but agreement on the relevant area is often difficult to reach.

6.3.3 The Equi-ratio Method

In this method the boundary is defined as the loci of points having a constant ratio of distance between the baselines and basepoints of the two States. Any ratio of distances may be chosen to arrive at an equitable solution. The most straightforward application is the ratio 1:1 which results in the equidistant line. Any other ratio chosen will result in a series of conic segments, using the terms of plane geometry, a particularly interesting case being that of a small island State lying off the straight coast of a large State. A set of different ratios will provide a set of ellipses with the island State being located at one focal point of the ellipses. This method has not been used to date (2004). One commercial GIS system does have the functionality to calculate this type of boundary.

6.3.4 Methods related to the "General Direction" of the Coastline

The most common example of this is the perpendicular to the "general direction of the coast". The general direction may be determined on a limited length of coastline either side of the land terminus, or it may be determined on the basis of the whole of the coasts of both States, or even on the general direction of a section of the whole land mass embracing several States.

A method of establishing the general direction may be to divide a designated sector of coastline, on either side of the boundary, into short segments between evenly spaced basepoints. The azimuths of the lines linking all the consecutive basepoints are averaged to obtain an average 'direction'. This is unlikely, however, to produce a less arbitrary or more reasonable result than the rather simpler methods already described.

The technical expert should provide, and justify, several alternative general direction lines.

In plane geometry a perpendicular to a straight line is also a line of equidistance relative to that line. This method of delimitation may therefore be seen as a special case of equidistance but it will be essential to compute the results in geodetic terms.

The question of what constitutes a "straight line" has already been discussed in Section 3.9. The line of "general direction" has usually been decided from charts on the Mercator projection, and has therefore been a loxodrome. A loxodrome is also a line of constant compass bearing, and so at any point throughout its length its direction will be constant. It is possible that in some cases the "general direction" will have been determined on some other projection or by geodetic computation, in which case, the direction will not necessarily be constant throughout its length.

At low latitudes - within 10 degrees of the Equator, the differences between geodesics and loxodromes are minimal, particularly if one is dealing with such imprecise concepts as "general direction". At higher latitudes, though, and within the limits for which they are designed, a pictorially more accurate representation of the form of a coastline is given by the Transverse Mercator or Lambert Conformal projections. A straight line representing the general direction on these projections would not be a line of constant bearing: it would be a geodesic, and the azimuth of a geodesic changes throughout its length.

In high latitudes a "perpendicular" loxodrome (unless it is also a meridian) is unlikely even to approximate a line of equidistance from the line of "general direction". In any particular case the actual choice of line will depend on a number of factors, and there is no established custom in the matter.

A variant of the perpendicular is the bisector line. In this method the general direction of the coast, or part of the coast, of both the adjacent States, or of opposite States in certain circumstances, is determined. The delimitation line is then taken to be the bisector of the angle formed by these two lines of general direction at the land boundary terminus. This solution is suited to a coast where the general direction changes markedly at or near the boundary. Although superficially attractive, the solution may result in unbalanced areas on the ellipsoid.

6.4 OTHER METHODS

Many other methods of boundary delimitation may be imagined or have been used. The following are only a few.

6.4.1 The Thalweg Concept

The thalweg is defined as the line of maximum depth along a river channel or lake but may be considered in any coastal channel. The principle has been employed for centuries where such water bodies form the boundary. Its most obvious use as a boundary lies in areas of shallow water in the territorial sea where it is desirable that the navigational channels giving access to both States should not be under the sole control of one State. In the deeper waters seaward of rivers or estuaries, justification of using the thalweg method is uncertain.

Where the use of the thalweg is relevant, its line may be determined from charts. In some cases a special survey may be necessary.

If the thalweg is following a navigable channel in unstable areas it will change as the channel changes. It can only remain as a stationary line if it is used in waters too deep for changes in bathymetry to matter. If the inshore section of a maritime boundary is formed by an ambulatory thalweg it must be linked in some way to the fixed offshore section of the boundary. This may be done by terminating the thalweg at a defined line (a line of bearing from a fixed point, or a meridian or parallel) which passes through the position determined as the landward end of the fixed section of boundary. The inshore section of the boundary, at any particular time, will be the thalweg as it is at that time, and will terminate at whatever point it intersects the defined line. The boundary will then continue along the part of the defined line linking the point of intersection and the position of the landward end of the fixed offshore section.

6.4.2 Prolongation of Land Boundaries

If the land boundary pursues a straight course, perhaps more or less perpendicular to the direction of the coast, for some distance before reaching its coastal terminal point, it may be decided to continue it in the same direction to form at least a near-shore section of the maritime boundary. It is unlikely that such a prolongation will be satisfactory as a complete maritime boundary. At all events the same geodetic considerations as before apply in relation to the question of "straight" etc.

6.4.3 Arbitrary Lines

For various reasons, perhaps historical or political, agreed maritime boundaries may be simple geodesics or loxodromes such as a parallel of latitude, a meridian, parallel lines forming a corridor, and so on.

Although described as arbitrary, the lines may be supported by a sound rationale. For instance, where the whole length of a continental coastline follows the same general direction, a series of bilateral boundaries all parallel to one another will produce the most equitable solution for all the States involved notwithstanding that, if each delimitation problem were examined in isolation, different solutions might appear equitable. Similarly, where a State has a very short frontage on a regular coastline, the most equitable boundaries with its neighbours might be parallel lines forming a corridor of the same width as its length of coastline.

6.4.4 Enclaving

There are several examples, both judicial and bilateral, where a coastal feature, usually an island or islands distanced geographically from the coastal State, has not been given its full maritime entitlement; i.e. it has been enclaved in one form or another.

6.5 PROPORTIONALITY

In essence, the concept of proportionality has been taken to date to mean that the relevant maritime areas should be divided in proportion to the relative lengths of the coastline of the two States. This concept may have been applied in bilateral agreements, but has only been used as test of the equitability of the delimited line in court cases to date (2006).

6.6 JUDICIAL PRECEDENT

There have been several decisions of the International Court of Justice or of <u>ad hoc</u> Tribunals that are of significant interest when considering bilateral delimitation. They are included in the bibliography.

These decisions are essential reading for anyone engaged in delimitation work, but they must be studied with care, so that the particular circumstances that determined the decisions are understood and not misapplied in different circumstances. Finally, it should be emphasized that the technical branch of the government must work closely with the legal branch when interpreting the international law of maritime boundary delimitation and applying the principles and methods to a particular situation.

APPENDIX 1 - GLOSSARY

INTRODUCTION

The 1982 United Nations Convention of the Law of the Sea includes terms of a technical nature that may not always be readily understood by those seeking general information or those called upon to assist in putting the Convention articles into effect. Such readers could vary from politicians and lawyers to hydrographers, land surveyors, cartographers, geographers and others. The need to understand such terms may become of particular concern to those involved in maritime boundary delimitation. Accordingly, the Technical Aspects of the Law of the Sea (TALOS) Working Group of the IHO has produced this Glossary to assist all readers of the Convention in understanding the hydrographic, cartographic and oceanographic terms used.

Where definitions have been extracted verbatim from the Convention or where the Working Group has defined the terms itself, they will appear in bold type in the documents. Explanatory notes appear beneath these in lighter type. Where appropriate, reference is made to the articles of the Convention.

Care has been taken to provide definitions that are within the context of the subject matter. Where this has not been an overriding consideration, consistency with the Hydrographic Dictionary, Part I, Fourth Edition has been a goal.

The Glossary should be read in conjunction with Appendix 2. This provides more detailed information on the applications of the Convention.

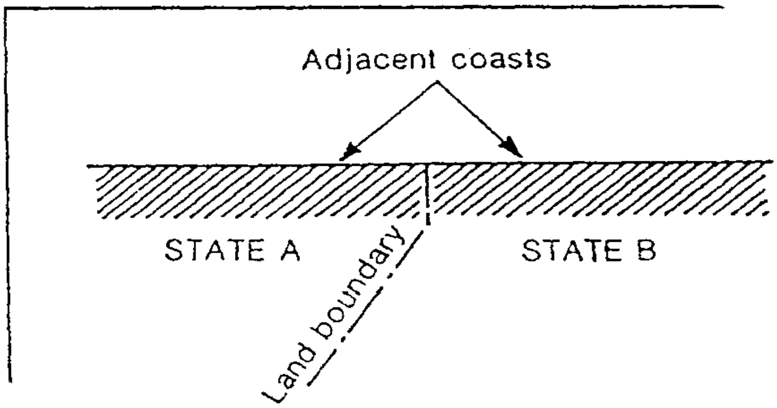
INDEX OF TERMS IN THE GLOSSARY

GLOSSARY

1 **ADJACENT COASTS**

The coasts lying either side of the land boundary between two adjoining States.

Figure 1 - Adjacent Coasts



2 **AID TO NAVIGATION**

A device, external to a vessel, charted or otherwise published, serving the interests of safe navigation.

This definition is in accordance with the International Convention for the Safety of Life at Sea (SOLAS) and the International Hydrographic Dictionary.

These devices are referred to in the Convention (Art. 21.1 (b), 43 (a)) as "navigational aids".

See: NAVIGATIONAL AID

3 **ARCHIPELAGIC BASELINES**

See: BASELINE

4 **ARCHIPELAGIC SEA LANE**

As defined in Art. 53.

See: ROUTEING SYSTEM; TRAFFIC SEPARATION SCHEME

5 **ARCHIPELAGIC STATE**

As defined in Art. 46.

See: ARCHIPELAGIC WATERS; BASELINE; ISLANDS

6 **ARCHIPELAGIC WATERS**

The waters enclosed by archipelagic baselines.

See: 46,47,49.

See: ARCHIPELAGIC STATE; BASELINE ; INTERNAL WATERS

7 **AREA**

As defined in Art. 1.1.(1).

See: BASELINE; CONTINENTAL SHELF; DEEP OCEAN FLOOR; EXCLUSIVE ECONOMIC ZONE; SEA-BED; SUBSOIL

8 **ARTIFICIAL ISLAND**

See: INSTALLATION (OFF-SHORE)

9 **ATOLL**

A ring-shaped reef with or without an island situated on it surrounded by the open sea, that encloses or nearly encloses a lagoon.

An atoll is usually formed on the top of a submerged volcano by coral polyps.

Where islands are situated on atolls the territorial sea baseline is the seaward low-water line of the reef as shown by the appropriate symbol on charts officially recognized by the coastal State (Art. 6).

For the purpose of computing the ratio of water to land when establishing archipelagic waters, atolls and the waters contained within them may be included as part of the land area (Art. 47.7).

See: ARCHIPELAGIC WATERS; BASELINE; ISLANDS; LOW-WATER LINE; REEF

10 **BANK**

With reference to Art. 76.6.

A submarine elevation located on a continental margin over which the depth of water is relatively shallow.

With reference to Art. 9 it is that portion of land that confines a river.

It could also be a shallow area of shifting sand, gravel, mud, etc. such as a sand bank or a mud bank usually occurring in relatively shallow waters and constituting a danger to navigation.

See: CONTINENTAL SHELF, LOW TIDE ELEVATION

11 **BASELINE**

The line from which the outer limits of a State's territorial sea and certain other outer limits of coastal State jurisdiction are measured.

The term refers to the baseline from which the breadth of the territorial sea, the outer limits of the Contiguous Zone (Art. 33.2), the Exclusive Economic Zone (Art. 57) and, in some cases, the Continental Shelf (Art. 76) are measured. It is also the dividing line between internal waters and territorial seas.

See: INTERNAL WATERS.

The type of the territorial sea baseline may vary depending on the geographical configuration of the locality ... etc.

The "normal baseline" is the low-water line along the coast (including the coasts of islands) as marked on large-scale charts officially recognized by the coastal State (Arts. 5 and 121.2).

See: LOW-WATER LINE.

In the case of islands situated on atolls or of islands having fringing reefs, the baseline is the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognized by the coastal State (Art. 6).

Where a low-tide elevation is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the mainland or an island, the low-water line on that elevation may be used as part of the baseline (Art. 13).

See: LOW-TIDE ELEVATION

Straight baselines are a system of straight lines joining specified or discrete points on the low-water line, usually known as straight baseline turning points, which may be used only in localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity (Art.7.1).

See: STRAIGHT LINE

Archipelagic baselines are straight lines joining the outermost points of the outermost islands and drying reefs which may be used to enclose all or part of an archipelago which forms all or part of an archipelagic State (Art. 47).

12 **BASEPOINT**

A basepoint is any point on the baseline. In the method of straight baselines, where one straight baseline meets another baseline at a common point, one line may be said to "turn" at that point to form another baseline. Such a point may be termed a "baseline turning point" or simply "basepoint".

13 **BAY**

For the purposes of this Convention, a bay is a well-marked indentation whose penetration is in such proportion to the width of its mouth as to contain land-locked waters and constitute more than a mere curvature of the coast. An indentation shall not, however, be regarded as a bay unless its area is as large as, or larger than, that of the semi-circle whose diameter is a line drawn across the mouth of that indentation (Art. 10.2).

This definition is purely legal and is applicable only in relation to the determination of the limits of maritime zones. It is distinct from and does not replace the geographical definitions used in other contexts.

This definition does not apply to "historic" bays (Art. 10.6).

See: HISTORIC BAYS

14 **CAP**

With reference to Art. 76.6

A submarine feature with a rounded cap-like top. Also defined as a plateau or flat area of considerable extent, dropping off abruptly on one or more sides.

15 **CHART**

A NAUTICAL CHART specially designed to meet the needs of marine navigation. It depicts such information as depths of water, nature of the seabed, configuration and nature of the coast, dangers and aids to navigation, in a standardised format; also called simply, Chart.

See: BASELINE; COAST; DANGER TO NAVIGATION; GEODETIC DATUM; LOW-WATER LINE; NAVIGATION AID; SEA-BED

16 **CLOSING LINE**

A dividing line between the internal waters and the territorial seas of a coastal State enclosing a river mouth (Art. 9), a bay (Art. 10) or a harbour (Art. 11); of the archipelagic waters of an archipelagic State (Art. 50).

See: ARCHIPELAGIC STATE; BASELINE; BAY; HARBOUR WORKS; INTERNAL WATERS and LOW-WATER LINE

17 **COAST**

The edge or margin of land next to the sea.

See: BASELINE and LOW-WATER LINE

18 **CONTIGUOUS ZONE**

1. In a zone contiguous to its territorial sea, described as the contiguous zone, the coastal State may exercise the control necessary to:

   (a) prevent infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea;

   (b) punish infringement of the above laws and regulations committed within its territory or territorial sea.

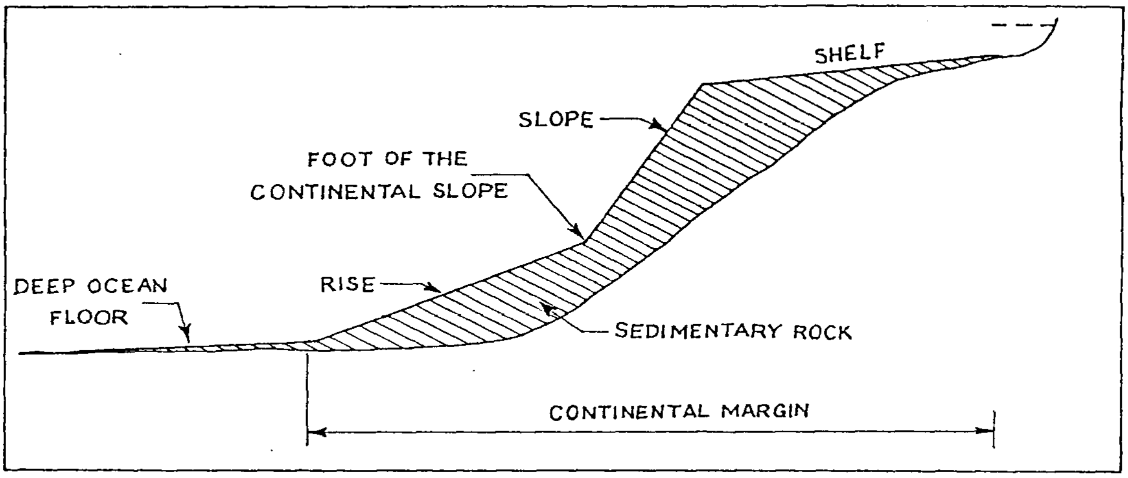
2. The contiguous zone may not extend beyond 24 nautical miles from the baselines from which the breadth of the territorial sea is measured (Art.33).

See: BASELINE ; EXCLUSIVE ECONOMIC ZONE ; HIGH SEAS

19 **CONTINENTAL MARGIN**

As defined in Art. 76.3 as follows: "The continental margin comprises the submerged prolongation of the land mass of the coastal State, and consists of the sea-bed and subsoil of the shelf, the slope and the rise. It does not include the deep ocean floor with its oceanic ridges or the subsoil thereof".

Figure 2 - Profile of the Continental Margin



See: CONTINENTAL RISE; CONTINENTAL SHELF; CONTINENTAL SLOPE; FOOT OF THE CONTINENTAL SLOPE; DEEP OCEAN FLOOR; SEA-BED; SHELF, SUBSOIL and Appendix 2.

20 **CONTINENTAL RISE**

A submarine feature which is that part of the continental margin lying between the continental slope and the deep ocean floor; simply called the Rise in the Convention.

It usually has a gradient of 0.5° or less and a generally smooth surface consisting of sediment.

See: CONTINENTAL MARGIN; CONTINENTAL SLOPE; DEEP OCEAN FLOOR; FOOT OF THE CONTINENTAL SLOPE

21 **CONTINENTAL SHELF**

For the purposes of the Convention it is defined in Art. 76.1 as follows:

"The continental shelf of a coastal State comprises the sea-bed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance".

The limits of the continental shelf or continental margin are determined in accordance with the provisions of Art. 76 of the Convention. If the continental margin extends beyond a 200 nautical mile limit measured from the appropriate baselines the provisions of Art. 76(4) to (10) apply.

See: CONTINENTAL MARGIN, OUTER LIMIT

22 **CONTINENTAL SLOPE**

That part of the continental margin that lies between the shelf and the rise. Simply called the slope in Art. 76.3.

The slope may not be uniform or abrupt, and may locally take the form of terraces. The gradients are usually greater than 1.5°.

See: CONTINENTAL MARGIN; CONTINENTAL SHELF; CONTINENTAL RISE; DEEP OCEAN FLOOR and FOOT OF THE CONTINENTAL SLOPE

23 **DANGER TO NAVIGATION**

A hydrographic feature or environmental condition that might hinder, obstruct, endanger or otherwise prevent safe navigation.

24 **DEEP OCEAN FLOOR**

The surface lying at the bottom of the deep ocean with its oceanic ridges, beyond the continental margin.

The continental margin does not include the deep ocean floor with its oceanic ridges or the subsoil thereof.

See: CONTINENTAL MARGIN; OCEANIC RIDGE; SEA-BED; SUBMARINE RIDGE and SUBSOIL

25 **DELIMITATION**

See: MARITIME DELIMITATION

26 **DELTA**

A tract of alluvial land enclosed and traversed by the diverging mouths of a river.

In localities where the method of straight baselines is appropriate, and where because of the presence of a delta and other natural conditions the coastline is highly unstable, appropriate Basepoints may be selected along the furthest seaward extent of the low-water line and, notwithstanding subsequent regression of the low-water line, the straight baselines shall remain effective until changed by the Coastal State in accordance with the Convention (Art.7.2).

See: BASELINE and LOW-WATER LINE

27 **DESKTOP STUDY**

In the Article 76 context, a Desktop Study consists of the assembly and analysis of existing information, leading to an assessment of a coastal State's prospects for establishing an extended continental shelf, and to an estimate of the level of effort that would be required to establish the outer limit of that extension.

See: CONTINENTAL SHELF

28 **DUE PUBLICITY**

Notification of a given action for general information through appropriate authorities within a reasonable amount of time in a suitable manner.

Under the provisions of the Convention, States shall give due publicity, inter alia, to charts or lists of geographical coordinates defining the baselines and some limits and boundaries (Arts. 16.2, 47.9, 75.2 and 84.2), to laws and regulations pertaining to innocent passage (Art. 21.3), and to sea lanes and traffic separation schemes established in the territorial sea (Art. 22.4) and archipelagic waters (Art. 53.10).

In addition to notification to concerned States through diplomatic channels, more immediate dissemination to mariners may be achieved by passing the information directly to national Hydrographic Offices for inclusion in their Notices to Mariners.

See: BASELINE; CHART; GEOGRAPHICAL COORDINATES; TRAFFIC SEPARATION SCHEME

29 **ELLIPSOID**

The Ellipsoid is a geometric shape that closely approximates the shape of the Geoid. It is a smooth mathematical surface upon which it is possible to perform exact mathematical calculations that would not be practical on the Geoid with its complex, irregular shape.

There are several reference ellipsoids. Some approximate the Geoid on a global basis, while others approximate it over particular geographic regions. The coordinates of any given point on the surface of the Earth will vary according to the reference ellipsoid that is in use. The process of converting coordinates from one reference ellipsoid to another is known as transformation. Transformation parameters are available for most reference ellipsoids.

See: GEOID

30 **ENCLOSED SEA**

As defined in Art. 122 as follows:

"For the purposes of this Convention, "enclosed or semi-enclosed sea" means a gulf, basin, or sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States".

31 **EQUIDISTANCE LINE**

See: MEDIAN LINE

32 **ESTUARY**

The tidal mouth of a river, where the seawater is measurably diluted by the fresh water from the river.

See: BAY; RIVER; DELTA

33 **EXCLUSIVE ECONOMIC ZONE (EEZ)**
As defined in Art. 55.

The zone may not be extended beyond 200 nautical miles from the territorial sea baselines (Art. 57).

The rights and jurisdictions of a coastal State in the EEZ are detailed in Art. 56. Other aspects of the EEZ are to be found in Part 5 of the Convention.

34 FACILITY (NAVIGATIONAL)

See: AID TO NAVIGATION

35 FACILITY (PORT)

See: HARBOUR WORKS

36 FOOT OF THE CONTINENTAL SLOPE

"In the absence of evidence to the contrary, the foot of the continental slope shall be determined as the point of maximum change of gradient at its base" (Art. 76.4(b)).

It is the point where the continental slope meets the continental rise or, if there is no rise, the deep ocean floor.

To determine the maximum change of gradient requires adequate bathymetry covering the slope and a reasonable extent of the rise, from which a series of profiles may be drawn and the point of maximum change of gradient located.

The two methods laid down in Art. 76.4 for determining the outer limit of the continental shelf depend upon the foot of the continental slope.

See: CONTINENTAL RISE; CONTINENTAL SHELF; CONTINENTAL SLOPE

37 GEOID

The Geoid is used to portray the shape of the Earth's surface to which the oceans would conform over the entire Earth, if free to adjust to the combined effect of the Earth's mass attraction and the centrifugal force of the Earth's rotation.

In oceanic regions, the Geoid is an approximation of the sea surface, whereas in continental regions, it differs from the land surface in both level and shape.

See: ELLIPSOID

38 GEODESIC

A Geodesic is a curve that defines the shortest distance between two points on a given surface. In the context of the Law of the Sea, it is assumed that the Geodesic is calculated on a specific reference Ellipsoid.

The geodesic is one of two methods (the other being the loxodrome) for defining straight-line segments of a territorial sea baseline.

See: BASELINE, LOXODROME, STRAIGHT LINE, and ELLIPSOID

39 **GEODETIC DATA**

Parameters defining geodetic or astronomical reference systems and their mutual relations; horizontal, vertical and/or three dimensional coordinates of points referred to such systems; observations of high precision from which such coordinates may be derived; ancillary data such as gravity, deflections of the vertical or geoid separation at points or areas referred to such systems.

See: GEODETIC DATUM; GEODETIC REFERENCE SYSTEMS

40 **GEODETIC DATUM (see Section 2.4)**

A geodetic datum positions and orients a geodetic reference system in relation to the geoid and the astronomical reference system.

A local or regional datum takes a reference ellipsoid to best fit the geoid in its (limited) area of interest and its origin of Cartesian coordinates will usually be displaced from the mass-centre of the earth - but, if well oriented, it will have its Cartesian axes parallel to those of the astronomical reference system.

A global datum will normally take the most recent international geodetic reference system (currently GRS 80) - which is designed to best fit the global geoid, it will therefore seek to place its origin of Cartesian coordinates at the mass-centre of the earth, with its Cartesian axes well oriented.

If a datum point is used to define a datum, one will specify:-

a) <u>Deflections of the vertical</u> (Astronomic minus geodetic latitude, longitude and azimuth) there - if not zero they will need to satisfy the Laplace equation connecting astronomic and geodetic longitudes and azimuths, or the datum will not be well oriented.

b) <u>Geoidal Separation</u> there - which may or may not be zero.

It is not normal to use a datum point for global datums as the mass-centre requirement cannot then be met.

The locally horizontal component of a (three-dimensional) geodetic datum is also known as the <u>horizontal datum</u> or <u>horizontal reference datum</u>.

The position of a point common to two different surveys on different geodetic datums will be assigned two different sets of geodetic geographical coordinates, it is important therefore to know the geodetic datum when a position is defined.

The datum must be specified when lists of geographicals are used to define the baselines and the limits of some zones of jurisdiction (Arts. 16.1, 47.8, 75.1, 84.1).

See: BASELINE; GEOGRAPHICAL COORDINATES; GEODETIC DATA; GEODETIC REFERENCE SYSTEMS

41 **GEODETIC REFERENCE SYSTEMS (see Section 2.3)**

A geodetic reference system is defined by specifying an ellipsoid of rotation (also termed a spheroid by Anglo-U.S. Geodesists) which requires:

a) Semi-axis major and flattening

or

b) Semi-axis major and second zonal gravity harmonic (J)

The second alternative has been adopted by the IAG (they also specify the earth's gravitational constant, GM, and the angular velocity, W) but the two definitions are equivalent in practice.

Points at zero geodetic height lie on the surface of the ellipsoid, while other points are projected down (by the amount of their geodetic height) to the feet of normals to the ellipsoid.

Coordinates are three-dimensional Cartesians referred to an origin at the centre of the spheroid with the Z-axis along the axis of symmetry, or geodetic geographicals with an associated geodetic height.

See: GEOGRAPHICAL COORDINATES; GEODETIC DATA and GEODETIC DATUM

42 **GEOGRAPHICAL COORDINATES**

Angular parameters of latitude and longitude which define the position of a point on the earth's surface and which, in conjunction with a height, similarly define positions vertically above or below such a point.

<u>Astronomical</u> latitude and longitude relate to the mean axis of rotation of the earth and the direction of the local plumb-line vertical: latitude is the angle this vertical makes with a plane normal to the rotation axis; longitude is the angle that a plane containing this vertical and a line parallel to the rotation axis makes with a reference plane through the rotation axis (the Greenwich Meridian plane).

<u>Geodetic</u> latitude and longitude are similarly defined with the earth's rotation axis replaced by that of the reference ellipsoid (the z-axis); the plumb-line vertical replaced by the normal to the reference ellipsoid; and the plane of the meridian of Greenwich replaced by the xz-coordinate plane of the reference ellipsoid.

Latitude varies from 0 to 90 degrees North or South of the equator; lines joining all points of equal latitude are known as <u>parallels of latitude</u> (or just "parallels").

Longitude varies from 0 to 180 degrees East or West of the Greenwich Meridian; lines joining all points of equal longitude are known as meridians.

43 **GREAT CIRCLE**

A Great Circle is a circle drawn on a surface of a sphere, where the centre of the circle is coincident with the centre of the sphere.

The shortest distance between two points on the surface of a sphere is defined by the segment of the Great Circle that passes through those tow points.

See: GEODESIC, LOXODROME

44 **HARBOUR WORKS**

Permanent manmade structures built along the coast which form an integral part of the harbour system such as jetties, moles, quays or other port facilities, coastal terminals, wharves, breakwaters, sea walls, etc. (Art. 11).

Such harbour works may be used as part of the baseline for the purpose of delimiting the territorial sea and other maritime zones.

See: BASELINE; PORT

45 **HISTORIC BAY**

See Art. 10.6. This term has not been defined in the Convention. Historic bays need not meet the requirements prescribed in the definition of "bay" contained in Art. 10.2.

46 **HYDROGRAPHIC SURVEY**

The science of measuring and depicting those parameters necessary to describe the precise nature and configuration of the seabed and coastal strip, its geographical relationship to the landmass, and the characteristics and dynamics of the sea.

Hydrographic surveys may be necessary to determine the features that constitute baselines or Basepoints and their geographical positions.

During innocent passage, transit passage, and archipelagic sea-lane passage of foreign ships, including marine scientific research and hydrographic survey ships, may not carry out any research or survey activities without the prior authorization of the coastal States (Arts. 19.2 (j), 40 and 54).

See: BASELINE; GEOGRAPHICAL COORDINATES

47 **INSTALLATION (OFF-SHORE)**

Manmade structure in the territorial sea, exclusive economic zone or on the continental shelf usually for the exploration or exploitation of marine resources. They may also be built for other purposes such as marine scientific research, tide observations, etc.

Off-shore installations or artificial islands shall not be considered as permanent harbour works (Art. 11), and therefore may not be used as part of the baseline from which to measure the breadth of the territorial sea.

Where States may establish straight baselines or archipelagic baselines, low tide elevations having lighthouses or similar installations may be used as Basepoints (Arts.7.4 and 47.4).

Artificial islands, installations and structures do not possess the status of islands. They have no territorial sea of their own, and their presence does not affect the delimitation of the territorial sea, the exclusive economic zone or the continental shelf (Art. 60.8).

Art. 60 provides, inter alia, for due notice to be given for the construction or removal of installations, and permanent means for giving warning of their presence must be maintained. Safety zones, not to exceed 500 metres, measured from their outer edges, may be established. Any installations abandoned or disused shall be removed, taking into account generally accepted international standards.

48 **INTERNAL WATERS**

As defined in Art. 8.1.

The relevant straits regime applies in a strait enclosed by straight baselines (Art. 35(a)).

A State exercises complete sovereignty over its internal waters with the exception that a right of innocent passage exists for foreign vessels in areas that had not been considered as internal waters prior to the establishment of a system of straight baselines (Art. 8.2).

See: BASELINE; BAY; COASTLINE; LOW-WATER LINE; HISTORIC BAY; INSTALLATIONS (OFF-SHORE); RIVER

49 **INTERNATIONAL NAUTICAL MILE**

The International Nautical Mile has a length of 1852 metres, which is equivalent to the length of a minute of latitude at about 44º latitude.

For general navigational purposes, the International Nautical Mile can be approximated by one minute of latitude, which varies in length from 1843 to 1862 metres depending on latitude.

50 **ISLANDS**

As defined in Art. 121.1.

Maritime zones of islands are referred to in Art. 121.2.

See: ATOLL; BASELINE; CONTIGUOUS ZONE; CONTINENTAL MARGIN; EXCLUSIVE ECONOMIC ZONE; ROCK; TIDE

51 **ISOBATH**

A line representing the horizontal contour of the sea-bed at a given depth.

See: Art. 76.5

52 **LAND TERRITORY**

A general term in the Convention that refers to both insular and continental land masses that are above water at high tide (Arts. 2.1 and 76.1).

See: TIDE

53 **LATITUDE**

See: GEOGRAPHICAL COORDINATES

54 **LONGITUDE**

See: GEOGRAPHICAL COORDINATES

55 **LOW-TIDE ELEVATION**

A low-tide elevation is a naturally formed area of land which is surrounded by and above water at low tide but submerged at high tide (Art.13.1).

Low-tide elevation is a legal term for what are generally described as drying banks or rocks. On nautical charts they should be distinguishable from islands.

Where a low-tide elevation is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the mainland or an island, the low-water line on that elevation may be used as the baseline for measuring the territorial sea (Art. 13.1).

Arts. 7.4 and 47.4 refer to the use of low-tide elevations as Basepoints in a system of straight baselines or archipelagic baselines.

See: BANK BASELINE; ISLAND; LOW-WATER LINE; CHART; TERRITORIAL SEA; INSTALLATION (OFF-SHORE)

56 **LOW-WATER LINE / LOW-WATER MARK**

The intersection of the plane of low water with the shore. The line along a coast, or beach, to which the sea recedes at low-water.

It is the normal practice for the low-water line to be shown as an identifiable feature on nautical charts unless the scale is too small to distinguish it from the high-water line or where there is no tide so that the high and low-water lines are the same.

The actual water level to which soundings on a chart are referred is known as Chart Datum.

See: BASELINE; CHART; TIDE and Appendix 2.

57 LOXODROME

A Loxodrome or Rhumb Line is a true straight line on a Mercator chart, where it has a constant azimuth. It is one of two methods (the other being the Geodesic) used to define straight-line segments of a territorial sea baseline.

Projected back onto the reference ellipsoid, a loxodrome will generally differ from a geodesic constructed between the same two points.

See: GEODESIC; TERRITORIAL SEA BASELINE

58 **MARITIME DELIMITATION**

The determination of a maritime boundary between States effected by agreement.

In the case of the territorial sea, failing agreement between the States concerned, delimitation is effected by a median line (Art. 15).

See: EXCLUSIVE ECONOMIC ZONE; BASELINE; CONTINENTAL SHELF; MEDIAN LINE; TERRITORIAL SEA

59 **MEDIAN LINE**

A line every point of which is equidistant from the nearest points on the baselines of two States.

It is usual to refer to "median line" in the case of opposite coasts and equidistance line in the case of adjacent coasts, although this distinction is not made in the Convention.

See: ADJACENT COASTS; BASELINE; EQUIDISTANCE LINE; OPPOSITE COASTS; TERRITORIAL SEA

60 **MILE**

See: NAUTICAL MILE

61 **MOUTH (BAY)**

Is the entrance to the bay from the ocean?

Art. 10.2 states, supra, "a bay is a well-marked indentation......etc.," and the mouth of that bay is "the mouth of that indentation". Arts. 10.3, 10.4, and 10.5 refer to "natural entrance points of a bay." Thus it can be said that the mouth of a bay lies between its natural entrance points.

In other words, the mouth of a bay is its entrance.

Although some States have developed standards by which to determine natural entrance points to bays, no international standards have been established.

See: BASELINE; BAY; CLOSING LINE; ESTUARY and LOW-WATER LINE

62 **MOUTH (RIVER)**

The place of discharge of a river into the ocean.

If a river flows directly into the sea, the baseline shall be a straight line across the mouth of the river between points on the low-water line of its banks (Art.9).Note that the French text of the Convention is "Si un fleuve se jette dans la mer sans former d'estuaire ..." (underlining added).

No limit is placed on the length of the line to be drawn.

The fact that the river must flow "directly into the sea" suggests that the mouth should be well marked, but otherwise the comments on the mouth of a bay apply equally to the mouth of a river.

See: BASELINE; CLOSING LINE; ESTUARY; LOW WATER LINE and RIVER

63 **NAUTICAL CHART**

See: CHART

64 **NAUTICAL MILE (M)**

A unit of distance used primarily in navigation. Most of the maritime nations have accepted the **international nautical mile** of 1852 meters adopted by the International Hydrographic Organization.

See: APPENDIX 2

65 **NAVIGATIONAL AID**

A shipboard instrument or device used to assist in the navigation of a vessel.

See: AID TO NAVIGATION

66 **NAVIGATIONAL CHART**

See: NAUTICAL CHART

67 **OCEANIC PLATEAU**

A comparatively flat topped elevation of the sea-bed which rises steeply from the ocean floor, and is of considerable extent across the summit.

For the purpose of computing the ratio of water to land enclosed within archipelagic baselines, land areas may, inter alia, include waters lying within that part of a steep-sided oceanic plateau which is enclosed or nearly enclosed by a chain of limestone islands and drying reefs lying on its perimeter (Art. 47.7).

See: ARCHIPELAGIC STATE; BASELINE

68 **OCEANIC RIDGE**

A long elevation of the deep ocean floor with either irregular or smooth topography and steep sides.

Such ridges are not part of the continental margin (Art. 76.3).

See: DEEP OCEAN FLOOR

69 **OPPOSITE COASTS**

The geographical relationship of the coasts of two States facing each other.

Maritime zones of States having opposite coasts may require boundary delimitation to avoid overlap.

70 **OUTER LIMIT**

The extent to which a coastal State claims or may claim a specific jurisdiction in accordance with the provisions of the Convention.

In the case of the territorial sea, the contiguous zone and the exclusive economic zone, the outer limits lie at a distance from the nearest point of the territorial sea baseline equal to the breadth of the zone of jurisdiction being measured (Arts. 4, 33.2, and 57).

In the case of the continental shelf, where the continental margin extends beyond 200 nautical miles from the baseline from which the territorial sea is measured, the extent of the outer limit is described in detail in Art.76.

See: BASELINE; CONTIGUOUS ZONE; CONTINENTAL MARGIN; CONTINENTAL SHELF; EXCLUSIVE ECONOMIC ZONE; ISOBATH; TERRITORIAL SEA

71 **PARALLEL OF LATITUDE**

See: GEOGRAPHICAL COORDINATES

72 **PLATFORM**

See: INSTALLATION (OFF-SHORE)

73 **PORT**

A place provided with various installations, terminals and facilities for loading and discharging cargo or passengers.

74 **REEF**

A mass of rock or coral which either reaches close to the sea surface or is exposed at low tide.

DRYING REEF. That part of a reef which is above water at low tide but submerged at high tide.

FRINGING REEF. A reef attached directly to the shore or continental landmass, or located in their immediate vicinity.
In the case of islands situated on atolls or of islands having fringing reefs, the baseline is the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognized by the coastal State (Art. 6).

See: ATOLL; BASELINE; ISLAND and LOW-WATER LINE

75 **RHUMB LINE**

See: LOXODROME

76 **RISE**

See: CONTINENTAL RISE

77 **RIVER**

A relatively large natural stream of water.

78 **ROADSTEAD**

An area near the shore where vessels are intended to anchor in a position of safety; often situated in a shallow indentation of the coast.
"Roadsteads which are normally used for loading, unloading and anchoring of ships, and which would otherwise be situated wholly or partly outside the outer limit of the territorial sea, are included in the territorial sea" (Art. 12).

In most cases roadsteads are not clearly delimited by natural geographical limits, and the general location is indicated by the position of its geographical name on charts. If Art. 12 applies, however, the limits must be shown on charts or must be described by a list of geographical coordinates.

See: CHART; GEOGRAPHICAL COORDINATES; MARITIME DELIMITATION; TERRITORIAL SEA

79 **ROCK**

Consolidated lithology of limited extent.

There is no definition given in the Convention. It is used in Convention Art. 121.3 which states:

"Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf."

See: ISLAND; LOW-TIDE ELEVATION

80 **ROUTEING SYSTEM**

Any system of one or more routes and/or routeing measures aimed at reducing the risk of casualties; it includes traffic separation schemes, two-way routes, recommended tracks, areas to be avoided, inshore traffic zones, roundabouts, precautionary areas and deep-water routes.

81 **SAFETY AIDS**

See: AID TO NAVIGATION

82 **SAFETY ZONE**

Zones established by the coastal State around artificial islands, installations and structures in which appropriate measures to ensure the safety both of navigation and of the artificial islands, installations and structures are taken. Such zones shall not exceed a distance of 500 metres around them, except as authorized by generally accepted international standards or as recommended by the competent international organization (Arts. 60.4, 60.5).

See: INSTALLATION (OFF-SHORE)

83 **SCALE**

The ratio between a distance on a chart or map and a distance between the same two points measured on the surface of the earth (or other body of the Universe).
Scale may be expressed as a fraction or as a ratio. If on a chart a true distance of 50 000 metres is represented by a length of 1 metre the scale may be expressed as 1:50 000 or as 1/50 000. The larger the divisor the smaller is the scale of the chart.

See: CHART

84 **SEA-BED**

The top of the surface layer of sand, rock, mud or other material lying at the bottom of the sea and immediately above the subsoil.

The sea-bed may be that of the territorial sea (Art. 2.2), archipelagic waters (Art. 49.2), the exclusive economic zone (Art. 56), the continental shelf (Art. 76), the high seas (Art. 112.1), or the Area (Arts. 1.1.(1) and 133). It may be noted, however, that in reference to the surface layer seaward of the continental rise, Article 76 uses the term "deep ocean floor" rather than sea-bed.

See: AREA; CONTINENTAL SHELF; DEEP OCEAN FLOOR; EXCLUSIVE ECONOMIC ZONE; SUBSOIL

85 **SEDIMENTARY ROCK**

Rock formed by the consolidation of sediment that has accumulated in layers. (The term sedimentary rock is used in Art. 76.4.(a)(i).)

The sediments may consist of rock fragments or particles of various sizes (conglomerate, sandstone, shale), the remains or products of animals or plants (certain limestones and coal), the product of chemical action or of evaporation (salt, gypsum etc.) or a mixture of these materials.

86 **SEMI-ENCLOSED SEA**

See: ENCLOSED SEA, Art. 122

87 **SHELF**

Geologically an area adjacent to a continent or around an island extending from the low-water line to the depth at which there is usually a marked increase of slope to greater depth.

See: CONTINENTAL SHELF

88 **SIZE OF AREA**

The general requirements are laid down in Annex III Arts. 8 and 17.2 (a) of the Convention. The first of these articles requires that the applicant shall indicate the coordinates dividing the area.

The most common system of coordinates are those of latitude and longitude, although rectangular coordinates on the Universal Transverse Mercator Grid (quoting the appropriate Zone number), Marsden Squares, Polar Grid Coordinates etc. are also unambiguous. The Preparatory Commission has under consideration that applications for plans of work should define the areas by reference to the global system WGS. (Art. 2.12 of Draft Regulations on Prospecting, Exploration and Exploitation of Polymetallic Nodules in the Area, LOS/PCN/SCN. 3/WP 6).

See: GEOGRAPHICAL COORDINATES

89 **SLOPE**

See: CONTINENTAL SLOPE

90 **SPUR**

A subordinate elevation, ridge or rise projecting outward from a larger feature.

The maximum extent of the outer limit of the continental shelf along submarine ridges is 350 nautical miles from the baselines. This limitation however "... does not apply to submarine elevations that are natural components of the continental margin, such as plateaux, rises, caps, banks and spurs." (Art. 76.6).

See: BANK; CAP; CONTINENTAL SHELF; SUBMARINE RIDGE

91 **TEST OF APPURTENANCE**

In the context of Article 76, the test of appurtenance is applied by the Commission on the Limits of the Continental Shelf to seabed elevations that are identified in a coastal State's continental shelf submission, for the purpose of determining whether such elevations are legitimate components of that State's natural prolongation.

See: CONTINENTAL SHELF

92 **STRAIGHT BASELINE**

See: BASELINE

93 **STRAIGHT LINE**

Mathematically the line of shortest distance between two points in a specified space or on a specified surface.

See: BASELINE; CONTINENTAL MARGIN and CONTINENTAL SHELF

94 **STRAIT**

Geographically, a narrow passage between two landmasses or islands or groups of islands connecting two larger sea areas.
Only straits "used for international navigation" are classified as "international straits", and only such straits fall within the specific regime provided in the Convention Part III Sections 2 and 3.

95 **STRUCTURE**

See: INSTALLATION (OFF-SHORE)

96 **SUBMARINE CABLE**

An insulated, waterproof wire or bundle of wires or fibre optics for carrying an electric current or a message under water.

They are laid on or in the seabed, and the most common are telegraph or telephone cables, but they may also be carrying high voltage electric currents for national power distribution or to off-shore islands or structures.

They are usually shown on charts if they lie in area where they may be damaged by vessels' anchoring or trawling.

All states are entitled to lay submarine cables on the continental shelf subject to the provisions of Art. 79.

Arts. 113, 114 and 115 provide for the protection of submarine cables and indemnity for loss incurred in avoiding injury to them.

See: SUBMARINE PIPELINES

97 **SUBMARINE PIPELINES**

A line of pipes for conveying water, gas, oil etc., under water.

They are laid on or trenched into the sea-bed, and they could stand at some height above it. In areas of strong tidal streams and soft sea-bed material the sea-bed may be scoured from beneath sections of the pipe leaving them partially suspended.

They are usually shown on charts if they lie in areas where they may be damaged by vessels anchoring or trawling.

The delineation of the course for the laying of such pipelines on the continental shelf is subject to the consent of the coastal State.

Arts. 113, 114 and 115 provide for the protection of submarine pipelines and indemnity for loss incurred in avoiding to them.
All states are entitled to lay submarine pipelines on the continental shelf subject to the provisions of Art. 79.

See: SUBMARINE CABLES

98 **SUBMARINE RIDGE**

An elongated elevation of the sea floor, with either irregular or relatively smooth topography and steep sides.

On submarine ridges the outer limit of the continental shelf shall not exceed 350 nautical miles from the territorial sea baselines. This does not apply in the case of submarine elevations which are natural components of the continental margin of a coastal State (Art. 76.6).

See: CONTINENTAL SHELF

99 **SUBSOIL**

All naturally occurring matter lying beneath the sea-bed or deep ocean floor.

The subsoil includes residual deposits and minerals as well as the bedrock below.

The Area and a coastal State's territorial sea, archipelagic waters, exclusive economic zone and continental shelf all include the subsoil (Arts. 1.1(1), 2.2, 49.2, 56.1(a) and 76.1).

See: AREA; CONTINENTAL SHELF; EXCLUSIVE ECONOMIC ZONE; SEA-BED

100 **SUPERJACENT WATERS**

The waters overlying the sea-bed or deep ocean floor.

The Convention only refers to the superjacent waters over the continental shelf and those superjacent to the Area in Arts. 78 and 135 respectively.

See: AREA; CONTINENTAL SHELF; EXCLUSIVE ECONOMIC ZONE; SEA-BED; WATER COLUMN

101 **TERRITORIAL SEA**

A belt of water of a defined breadth but not exceeding 12 nautical miles measured seaward from the territorial sea baseline.

The coastal State's sovereignty extends to the territorial sea, its sea-bed and subsoil, and to the air space above it. This sovereignty is exercised subject to the Convention and to other rules of international law (Arts. 2 and 3).

The outer limit of the territorial sea is the line every point of which is at a distance from the nearest point of the baseline equal to the breadth of the territorial sea (Art. 4).

Art. 12 provides that certain roadsteads wholly or partly outside the territorial sea are included in the territorial sea; no breadth limitation is expressed.
The major limitations on the coastal State's exercise of sovereignty in the territorial sea are provided by the rights of innocent passage for foreign ships and transit passage and archipelagic sea-lanes passage for foreign ships and aircraft (Part II Section 3 and Part III Section 2, and Part IV of the Convention).

See: ARCHIPELAGIC SEA LANES; BASELINE; ISLANDS; LOW-TIDE ELEVATIONS; NAUTICAL MILE; ROADSTEADS

102 **THALWEG**

The line of maximum depth along a river channel. It may also refer to the line of maximum depth along a river valley or in a lake.

103 **TIDE**

The periodic rise and fall of the surface of the oceans and other large bodies of water due principally to the gravitational attraction of the Moon and Sun on a rotating earth.

CHART DATUM: The tidal level to which depths on a nautical chart are referred to constitutes a vertical datum being called Chart Datum.

While there is no universally agreed Chart Datum level, however under an International Hydrographic Conference Resolution (A 2.5) it "...shall be a plane so low that the tide will seldom fall below it".

See: CHART and LOW-WATER LINE

104 **TRAFFIC SEPARATION SCHEME**

A routeing measure aimed at the separation of opposing streams of traffic by appropriate means and by the establishment of traffic lanes.

See: ROUTEING SYSTEM

105 **WATER COLUMN**

A vertical continuum of water from sea surface to sea-bed.

See: SEA-BED; SUPERJACENT WATERS

APPENDIX 2

THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

Articles 1 - 123 and ANNEX II Articles 1 - 9

PART I

INTRODUCTION

Article 1
Use of terms and scope

1. For the purposes of this Convention:

(1) "Area" means the sea-bed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction;

(2) "Authority" means the International Sea-Bed Authority;

(3) "activities in the Area" means all activities of exploration for, and exploitation of, the resources of the Area;

(4) "pollution of the marine environment" means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities;

(5) (a) "dumping" means:

(i) any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea;

(ii) any deliberate disposal of vessels, aircraft, platforms or other man-made structures at sea;

(b) "dumping" does not include:

(i) the disposal of wastes or other matter incidental to, or derived from the normal operations of vessels, aircraft, platforms or other man-made structures at sea and their equipment, other than wastes or other matter transported by or to vessels, aircraft, platforms or other man-made structures at sea, operating for the purpose of disposal of such matter or derived from the treatment of such wastes or other matter on such vessels, aircraft, platforms or structures;

(ii) placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Convention.

2. (1) "States Parties" means States which have consented to be bound by this Convention and for which this Convention is in force.

(2) This Convention applies **mutatis mutandis** to the entities referred to in article 305, paragraph 1(b), (c), (d), (e) and (f), which become Parties to this Convention in accordance with the conditions relevant to each, and to that extent "States Parties" refers to those entities.

PART II

TERRITORIAL SEA AND CONTIGUOUS ZONE

SECTION 1 - GENERAL PROVISIONS

Article 2
Legal status of the territorial sea, of the air space over the territorial sea and of its bed and subsoil

1. The sovereignty of a coastal State extends, beyond its land territory and internal waters and, in the case of an archipelagic State, its archipelagic waters, to an adjacent belt of sea, described as the territorial sea.

2. This sovereignty extends to the air space over the territorial sea as well as to its bed and subsoil.

3. The sovereignty over the territorial sea is exercised subject to this Convention and to other rules of international law.

SECTION 2 - ITS OF THE TERRITORIAL SEA

Article 3
Breadth of the territorial sea

Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles, measured from baselines determined in accordance with this Convention.

Article 4
Outer limit of the territorial sea

The outer limit of the territorial sea is the line every point of which is at a distance from the nearest point of the baseline equal to the breadth of the territorial sea.

Article 5
Normal baseline

Except where otherwise provided in this Convention, the normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State.

Article 6
Reefs

In the case of islands situated on atolls or of islands having fringing reefs, the baseline for measuring the breadth of the territorial sea is the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognized by the coastal State.

Article 7
Straight baselines

1. In localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity, the method of straight baselines joining appropriate points may be employed in drawing the baseline from which the breadth of the territorial sea is measured.

2. Where because of the presence of a delta and other natural conditions the coastline is highly unstable, the appropriate points may be selected along the furthest seaward extent of the low-water line and, notwithstanding subsequent regression of the low-water line, the straight baselines shall remain effective until changed by the coastal State in accordance with this Convention.

3. The drawing of straight baselines must not depart to any appreciable extent from the general direction of the coast, and the sea areas lying within the lines must be sufficiently closely linked to the land domain to be subject to the régime of internal waters.

4. Straight baselines shall not be drawn to an from low-tide elevations, unless lighthouses or similar installations which are permanently above sea level have been built on them or except in instances where the drawing of baselines to and from such elevations has received general international recognition.

5. Where the method of straight baselines is applicable under paragraph 1, account may be taken, in determining particular baselines, of economic interests peculiar to the region concerned, the reality and the importance of which are clearly evidenced by long usage.

6. The system of straight baselines may not be applied by a State in such a manner as to cut off the territorial sea of another State from the high seas or an exclusive economic zone.

Article 8
Internal waters

1. Except as provided in Part IV, waters on the landward side of the baseline of the territorial sea form part of the internal waters of the State.

2. Where the establishment of a straight baseline in accordance with the method set forth in article 7 has the effect of enclosing as internal waters areas which had not previously been considered as such, a right of innocent passage as provided in this Convention shall exist in those waters.

Article 9
Mouths of rivers

If a river flows directly into the sea, the baseline shall be a straight line across the mouth of the river between points on the low-water line of its banks.

Article 10
Bays

1. This article relates only to bays the coasts of which belong to a single State.

2. For the purposes of this Convention, a bay is a well-marked indentation whose penetration is in such proportion to the width of its mouth as to contain land-locked waters and constitute more than a mere curvature of the coast. An indentation shall not, however, be regarded as a bay unless its area is as large as, or larger than, that of the semi-circle whose diameter is a line drawn across the mouth of that indentation.

3. For the purpose of measurement, the area of an indentation is that lying between the low-water mark around the shore of the indentation and a line joining the low-water mark of its natural entrance points. Where, because of the presence of islands, an indentation has more than one mouth, the semi-circle shall be drawn on a line as long as the sum total of the lengths of the lines across the different mouths. Islands within an indentation shall be included as if they were part of the water area of the indentation.

4. If the distance between the low-water marks of the natural entrance points of a bay does not exceed 24 nautical miles, a closing line may be drawn between these two low-water marks, and the waters enclosed thereby shall be considered as internal waters.

5. Where the distance between the low-water marks of the natural entrance points of a bay exceeds 24 nautical miles, a straight baseline of 24 nautical miles shall be drawn within the bay in such a manner as to enclose the maximum area of water that is possible with a line of that length.

6. The foregoing provisions do not apply to so-called "historic" bays, or in any case where the system of straight baselines provided for in article 7 is applied.

Article 11
Ports

For the purpose of delimiting the territorial sea, the outermost permanent harbour works which form an integral part of the harbour system are regarded as forming part of the coast. Off-shore installations and artificial islands shall not be considered as permanent harbour works.

Article 12
Roadsteads

Roadsteads which are normally used for the loading, unloading and anchoring of ships, and which would otherwise be situated wholly or partly outside the outer limit of the territorial sea, are included in the territorial sea.

Article 13
Low-tide elevations

1. A low-tide elevation is a naturally formed area of land which is surrounded by and above water at low tide but submerged at high tide. Where a low-tide elevation is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the mainland or an island, the low-water line on that elevation may be used as the baseline for measuring the breadth of the territorial sea.

2. Where a low-tide elevation is wholly situated at a distance exceeding the breadth of the territorial sea from the mainland or an island, it has no territorial sea of its own.

Article 14
Combination of methods for determining baselines

The coastal State may determine baselines in turn by any of the methods provided for in the foregoing articles to suit different conditions.

Article 15
Delimitation of the territorial sea between States with opposite or adjacent coasts

Where the coasts of two States are opposite or adjacent to each other, neither of the two States is entitled, failing agreement between them to the contrary, to extend its territorial sea beyond the median line every point of which is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each of the two States is measured. The above provision does not apply, however, where it is necessary by reason of historic title or other special circumstances to delimit the territorial seas of the two States in a way which is at variance therewith.

Article 16
Charts and lists of geographical co-ordinates

1. The baselines for measuring the breadth of the territorial sea determined in accordance with articles 7, 9 and 10, or the limits derived there from, and the lines of delimitation drawn in accordance with articles 12 and 15 shall be shown on charts of a scale or scales adequate for ascertaining their position. Alternatively, a list of geographical co-ordinates of points, specifying the geodetic datum, may be substituted.

2. The coastal State shall give due publicity to such charts or lists of geographical co-ordinates and shall deposit a copy of each such chart or list with the Secretary-General of the United Nations.

SECTION 3. INNOCENT PASSAGE IN THE TERRITORIAL SEA

SUBSECTION A - RULES APPLICABLE TO ALL SHIPS

Article 17
Right of innocent passage

Subject to this Convention, ships of all States, whether coastal or land-locked, enjoy the right of innocent passage through the territorial sea.

Article 18
Meaning of passage

1. Passage means navigation through the territorial sea for the purpose of:

   a) traversing that sea without entering internal waters or calling at a roadstead or port facility outside internal waters; or

   b) proceeding to or from internal waters or a call at such roadstead or port facility.

2. Passage shall be continuous and expeditious. However, passage includes stopping and anchoring, but only in so far as the same are incidental to ordinary navigation or are rendered necessary by **force majeure** or distress or for the purpose of rendering assistance to persons, ships or aircraft in danger or distress.

Article 19
Meaning of innocent passage

1. Passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State. Such passage shall take place in conformity with this Convention and with other rules of international law.

2. Passage of a foreign ship shall be considered to be prejudicial to the peace, good order or security of the coastal State if in the territorial sea it engages in any of the following activities:

a) any threat or use of force against the sovereignty, territorial integrity or political independence of the coastal State, or in any other manner in violation of the principles of international law embodied in the Charter of the United Nations;

b) any exercise or practice with weapons of any kind;

c) any act aimed at collecting information to the prejudice of the defence or security of the coastal State;

d) any act of propaganda aimed at affecting the defence or security of the coastal State;

e) the launching, landing or taking on board of any aircraft;

f) the launching, landing or taking on board of any military device;

g) the loading or unloading of any commodity, currency or person contrary to the customs, fiscal, immigration or sanitary laws and regulations of the coastal State;

h) any act of wilful and serious pollution contrary to this Convention;

i) any fishing activities;

j) the carrying out of research or survey activities;

k) any act aimed at interfering with any systems of communication or any other facilities or installations of the coastal State;

l) any other activity not having a direct bearing on passage.

Article 20
Submarines and other underwater vehicles

In the territorial sea, submarines and other underwater vehicles are required to navigate on the surface and to show their flag.

Article 21
Laws and regulations of the coastal State relating to innocent passage

1. The coastal State may adopt laws and regulations, in conformity with the provisions of this Convention and other rules of international law, relating to innocent passage through the territorial sea, in respect of all or any of the following:

(a) the safety of navigation and the regulation of maritime traffic;

(b) the protection of navigational aids and facilities and other facilities or installations;

(c) the protection of cables and pipelines;

(d) the conservation of the living resources of the sea;

(e) the prevention of infringement of the fisheries laws and regulations of the coastal State;

(f) the preservation of the environment of the coastal State and the prevention, reduction and control of pollution thereof;

(g) marine scientific research and hydrographic surveys;

(h) the prevention of infringement of the customs, fiscal, immigration or sanitary laws and regulations of the coastal State.

2. Such laws and regulations shall not apply to the design, construction, manning or equipment of foreign ships unless they are giving effect to generally accepted international rules or standards.

3. The coastal State shall give due publicity to all such laws and regulations.

4. Foreign ships exercising the right of innocent passage through the territorial sea shall comply with all such laws and regulations and all generally accepted international regulations relating to the prevention of collisions at sea.

Article 22
Sea lanes and traffic separation schemes in the territorial sea

1. The coastal State may, where necessary having regard to the safety of navigation, require foreign ships exercising the right of innocent passage through its territorial sea to use such sea lanes and traffic separation schemes as it may designate or prescribe for the regulation of the passage of ships.

2. In particular, tankers, nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances or materials may be required to confine their passage to such sea lanes.

3. In the designation of sea lanes and the prescription of traffic separation schemes under this article, the coastal State shall take into account:

(a) the recommendations of the competent international organization;

(b) any channels customarily used for international navigation;

(c) the special characteristics of particular ships and channels; and

(d) the density of traffic.

4. The coastal State shall clearly indicate such sea lanes and traffic separation schemes on charts to which due publicity shall be given.

Article 23
Foreign nuclear-powered and ships carrying nuclear or other inherently dangerous or noxious substances

Foreign nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances shall, when exercising the right of innocent passage through the territorial sea, carry documents and observe special precautionary measures established for such ships by international agreements.

Article 24
Duties of the coastal State

1. The coastal State shall not hamper the innocent passage of foreign ships through the territorial sea except in accordance with this Convention. In particular, in the application of this Convention or of any laws or regulations adopted in conformity with this Convention, the coastal State shall not:

(a) impose requirements on foreign ships which have the practical effect of denying or impairing the right of innocent passage; or

(b) discriminate in form or in fact against the ships of any State or against ships carrying cargoes to, from or on behalf of any State.

2. The coastal State shall give appropriate publicity to any danger to navigation, of which it has knowledge, within its territorial sea.

Article 25
Rights of protection of the coastal State

1. The coastal State may take the necessary steps in its territorial sea to prevent passage which is not innocent.

2. In the case of ships proceeding to internal waters or a call at a port facility outside internal waters, the coastal State also has the right to take the necessary steps to prevent any breach of the conditions to which admission of those ships to internal waters or such a call is subject.

3. The coastal State may, without discrimination in form or in fact among foreign ships, suspend temporarily in specified areas of its territorial sea the innocent passage of foreign ships if such suspension is essential for the protection of its security, including weapons exercises. Such suspension shall take effect only after having been duly published.

Article 26
Charges which may be levied upon foreign ships

1. No charge may be levied upon foreign ships by reason only of their passage through the territorial sea.

2. Charges may be levied upon a foreign ship passing through the territorial sea as payment only for specific services rendered to the ship. These charges shall be levied without discrimination.

SUBSECTION - B. RULES APPLICABLE TO MERCHANT SHIPS AND GOVERNMENT SHIPS OPERATED FOR COMMERCIAL PURPOSES

Article 27
Criminal jurisdiction on board a foreign ship

1. the criminal jurisdiction of the coastal State should not be exercised on board a foreign ship passing through the territorial sea to arrest any person or to conduct any investigation in connection with any crime committed on board the ship during its passage, save only in the following cases:

(a) if the consequences of the crime extend to the coastal State;

(b) if the crime is of a kind to disturb the peace of the country or the good order of the territorial sea;

(c) if the assistance of the local authorities has been requested by the master of the ship or by a diplomatic agent or consular officer of the flag State; or

(d) if such measures are necessary for the suppression of illicit traffic in narcotic drugs or psychotropic substances.

2. The above provisions do not affect the right of the coastal State to take any steps authorized by its laws for the purpose of an arrest or investigation on board a foreign ship passing through the territorial sea after leaving internal waters.

3. In the cases provided for in paragraphs 1 and 2, the coastal State shall, if the master so requests, notify a diplomatic agent or consular officer of the flag State before taking any steps, and shall facilitate contact between such agent or officer and the ship's crew. In cases of emergency this notification may be communicated while the measures are being taken.

4. In considering whether or in what manner an arrest should be made, the local authorities shall have due regard to the interests of navigation.

5. Except as provided in Part XII or with respect to violations of laws and regulations adopted in accordance with part V, the coastal State may not take any

steps on board a foreign ship passing through the territorial sea to arrest any person or to conduct any investigation in connection with any crime committed before the ship entered the territorial sea, if the ship, proceeding from a foreign port, is only passing through the territorial sea without entering internal waters.

Article 28
Civil jurisdiction in relation to foreign ships

1. The coastal State should not stop or divert a foreign ship passing through the territorial sea for the purpose of exercising civil jurisdiction in relation to a person on board the ship.

2. The coastal State may not levy execution against or arrest the ship for the purpose of any civil proceedings, save only in respect of obligations or liabilities assumed or incurred by the ship itself in the course or for the purpose of its voyage through the waters of the coastal State.

3. Paragraph 2 is without prejudice to the right of the coastal State, in accordance with its laws, to levy execution against or to arrest, for the purpose of any civil proceedings, a foreign ship lying in the territorial sea, or passing through the territorial sea after leaving internal waters.

SUBSECTION - C. RULES APPLICABLE TO WARSHIPS AND OTHER GOVERNMENT SHIPS OPERATED FOR NON-COMMERCIAL PURPOSES

Article 29
Definition of warships

For the purposes of this Convention, "warship" means a ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list or its equivalent, and manned by a crew which is under regular armed forces discipline.

Article 30
Non-compliance by warships with the laws and regulations of the coastal State

If any warship does not comply with the laws and regulations of the coastal State concerning passage through the territorial sea and disregards any request for compliance therewith which is made to it, the coastal State may require it to leave the territorial sea immediately.

Article 31
Responsibility of the flag State for damage caused by a warship or other government ship operated for non-commercial purposes

The flag State shall bear international responsibility for any loss or damage to the coastal State resulting from the non-compliance by a warship or other government ship operated for non-commercial purposes with the laws and regulations of the coastal State concerning passage through the territorial sea or with the provisions of this Convention or other rules of international law.

Article 32
Immunities of warships and other government ships operated for non-commercial purposes

With such exceptions as are contained in subsection A and in articles 30 and 31, nothing in this Convention affects the immunities of warships and other government ships operated for non-commercial purposes.

SECTION 4. CONTIGUOUS ZONE

Article 33
Contiguous zone

1. In a zone contiguous to its territorial sea, described as the contiguous zone, the coastal State may exercise the control necessary to:

   (a) prevent infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea;

   (b) punish infringement of the above laws and regulations committed within its territory or territorial sea.

2. The contiguous zone may not extend beyond 24 nautical miles from the baselines from which the breadth of the territorial sea is measured.

PART III

STRAITS USED FOR INTERNATIONAL NAVIGATION

SECTION 1. GENERAL PROVISIONS

Article 34
Legal status of waters forming straits used for international navigation

1. The régime of passage through straits used for international navigation established in this Part shall not in other respects affect the legal status of the waters forming such straits or the exercise by the States bordering the straits of their sovereignty or jurisdiction over such waters and their air space, bed and subsoil.

2. The sovereignty or jurisdiction of the States bordering the straits is exercised subject to this Part and to other rules of international law.

Article 35
Scope of this Part

Nothing in this Part affects:

(a) any areas of internal waters within a strait, except where the establishment of a straight baseline in accordance with the method set forth in article 7 has the effect of enclosing as internal waters areas which had not previously been considered as such;

(b) the legal status of the waters beyond the territorial seas of States bordering straits as exclusive economic zones or high seas; or

(c) the legal régime in straits in which passage is regulated in whole or in part by long-standing international conventions in force specifically relating to such straits.

Article 36
High seas routes or routes through exclusive economic zones through straits used for international navigation

This Part does not apply to a strait used for international navigation if there exists through the strait a route through the high seas or through an exclusive economic zone of similar convenience with respect to navigational and hydrographical characteristics; in such routes, the other relevant parts of this Convention, including the provisions regarding the freedoms of navigation and over flight, apply.

SECTION 2. TRANSIT PASSAGE

Article 37
Scope of this section

This section applies to straits which are used for international navigation between one part of the high seas of an exclusive economic zone and another part of the high seas or an exclusive economic zone.

Article 38
Right of transit passage

1. In straits referred to in article 37, all ships and aircraft enjoy the right of transit passage, which shall not be impeded; except that, if the strait is formed by an island of a State bordering the strait and its mainland, transit passage shall not apply if there exists seaward of the island a route through the high seas or through an exclusive economic zone of similar convenience with respect to navigational and hydrographical characteristics.

2. Transit passage means the exercise in accordance with this Part of the freedom of navigation and over flight solely for the purpose of continuous and expeditious transit of the strait between one part of the high seas or an exclusive economic zone and another part of the high seas or an exclusive economic zone. However, the requirement of continuous and expeditious transit does not preclude passage through the strait for the purpose of entering, leaving or returning from a State bordering the strait, subject to the conditions of entry to that State.

3. Any activity which is not an exercise of the right of transit passage through a strait remains subject to the other applicable provisions of this Convention.

Article 39
Duties of ships and aircraft during transit passage

1. Ships and aircraft, while exercising the right of transit passage, shall:

   (a) proceed without delay through or over the strait;

   (b) refrain from any threat or use of force against the sovereignty, territorial integrity or political independence of States bordering the strait, or in any other manner in violation of the principles of international law embodied in the Charter of the United Nations.

   (c) refrain from any activities other than those incident to their normal modes of continuous and expeditious transit unless rendered necessary by **force majeure** or by distress;

   (d) comply with other relevant provisions of this Part.

2. Ships in transit passage shall:

(a) comply with generally accepted international regulations, procedures and practices for safety at sea, including the International Regulations for preventing Collisions at Sea;

(b) comply with generally accepted international regulations, procedures and practices for the prevention, reduction and control of pollution from ships.

3. Aircraft in transit passage shall:

(a) observe the Rules of the Air established by the International Civil Aviation Organization as they apply to civil aircraft; state aircraft will normally comply with such safety measures and will at all times operate with due regard for the safety of navigation;

(b) at all times monitor the radio frequency assigned by the competent internationally designated air traffic control authority or the appropriate international distress radio frequency.

Article 40
Research and survey activities

During transit passage, foreign ships, including marine scientific research and hydrographic survey ships, may not carry out any research or survey activities without the prior authorization of the States bordering straits.

Article 41
Sea lanes and traffic separation schemes in straits used for international navigation

1. In conformity with this Part, States bordering straits may designate sea lanes and prescribe traffic separation schemes for navigation in straits where necessary to promote the safe passage of ships.

2. Such States may, when circumstances require, and after giving due publicity thereto, substitute other sea lanes or traffic separation schemes for any sea lanes or traffic separation schemes previously designated or prescribed by them.

3. Such sea lanes and traffic separation schemes shall conform to generally accepted international regulations.

4. Before designating or substituting sea lanes or prescribing or substituting traffic separation schemes, States bordering straits shall refer proposals to the competent international organization with a view to their adoption. The organization may adopt only such sea lanes and traffic separation schemes as may be agreed with the states bordering the straits, after which the States may designate, prescribe or substitute them.

5. In respect of a strait where sea lanes or traffic separation schemes through the waters of two or more States bordering the strait are being proposed, the States concerned shall co-operate in formulating proposals in consultation with the competent international organization.

6. States bordering straits shall clearly indicate all sea lanes and traffic separation schemes designated or prescribed by them on charts to which due publicity shall be given.

7. Ships in transit passage shall respect applicable sea lanes and traffic separation schemes established in accordance with this article.

Article 42
Laws and regulations of States bordering straits relating to transit passage

1. Subject to the provisions of this section, States bordering straits may adopt laws and regulations relating to transit passage through straits, in respect of all or any of the following:

(a) the safety of navigation and the regulation of maritime traffic, as provided in article 41;

(b) the prevention, reduction and control of pollution, by giving effect to applicable international regulations regarding the discharge of oil, oily wastes and other noxious substances in the strait;

(c) with respect to fishing vessels, the prevention of fishing, including the software of fishing gear;

(d) the loading or unloading of any commodity, currency or person in contravention of the customs, fiscal, immigration or sanitary laws and regulations of States bordering straits.

2. Such laws and regulations shall not discriminate in form or in fact among foreign ships or in their application have the practical effect of denying, hampering or impairing the right of transit passage as defined in this section.

3. States bordering straits shall give due publicity to all such laws and regulations.

4. Foreign ships exercising the right of transit passage shall comply with such laws and regulations.

5. The flag State of a ship or the State of registry of an aircraft entitled to sovereign immunity which acts in a manner contrary to such laws and regulations or other provisions of this Part shall bear international responsibility for any loss or damage which results to States bordering straits.

Article 43
Navigational and safety aids and other improvements and the prevention, reduction and control of pollution

User States and States bordering a strait should by agreement co-operate:

(a) in the establishment and maintenance in a strait of necessary navigational and safety aids or other improvements in aid of international navigation; and

(b) for the prevention, reduction and control of pollution from ships.

Article 44
Duties of States bordering straits

States bordering straits shall not hamper transit passage and shall give appropriate publicity to any danger to navigation or over flight within or over the strait of which they have knowledge. There shall be no suspension of transit passage.

SECTION 3. INNOCENT PASSAGE

Article 45
Innocent passage

1. The régime of innocent passage, in accordance with Part II, section 3, shall apply in straits used for international navigation:

(a) excluded from the application of the régime of transit passage under article 38, paragraph 1; or

(b) between a part of the high seas or an exclusive economic zone and the territorial sea of a foreign State.

2. There shall be no suspension of innocent passage through such straits.

PART IV

ARCHIPELAGIC STATES

Article 46
Use of terms

For the purposes of this Convention:

(a) "archipelagic State" means a State constituted wholly by one or more archipelagos and may include other islands;

(b) "archipelago" means a group of islands, including parts of islands, inter-connecting waters and other natural features which are so closely inter-related that such islands, waters and other natural features form an intrinsic geographical, economic and political entity, or which historically have been regarded as such.

Article 47
Archipelagic baselines

1. An archipelagic State may draw straight archipelagic baselines joining the outermost points of the outermost islands and drying reefs of the archipelago provided that within such baselines are included the main islands and an area in which the ratio of the area of the water to the area of the land, including atolls, is between 1 to 1 and 9 to 1.

2. The length of such baselines shall not exceed 100 nautical miles, except that up to 3 per cent of the total number of baselines enclosing any archipelago may exceed that length, up to a maximum length of 125 nautical miles.

3. The drawing of such baselines shall not depart to any appreciable extent from the general configuration of the archipelago.

4. Such baselines shall not be drawn to and from low-tide elevations, unless lighthouses or similar installations which are permanently above sea level have been built on them or where a low-tide elevation is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the nearest island.

5. The system of such baselines shall not be applied by an archipelagic State in such a manner as to cut off from the high seas or the exclusive economic zone the territorial sea of another State.

6. If the part of the archipelagic waters of an archipelagic State lies between two parts of an immediately adjacent neighbouring State, existing rights and all other legitimate interests which the latter State has traditionally exercised in such waters and all rights stipulated by agreement between those States shall continue and be respected.

7. For the purpose of computing the ratio of water to land under paragraph 1, land areas may include waters lying within the fringing reefs of islands and atolls, including that part of a steep-sided oceanic plateau which is enclosed or nearly enclosed by a chain of limestone islands and drying reefs lying on the perimeter of the plateau.

8. The baselines drawn in accordance with this article shall be shown on charts of a scale or scales adequate for ascertaining their position. Alternatively, lists of geographical co-ordinates of points, specifying the geodetic datum, may be substituted.

9. The archipelagic State shall give due publicity to such charts or lists of geographical co-ordinates and shall deposit a copy of each such chart or list with the Secretary-General of the United Nations.

Article 48
Measurement of the breadth of the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf

The breadth of the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf, shall be measured from archipelagic baselines drawn in accordance with article 47.

Article 49
Legal status of archipelagic waters, of the air space over archipelagic waters and of their bed and subsoil

1. The sovereignty of an archipelagic State extends to the waters enclosed by the archipelagic baselines drawn in accordance with article 47, described as archipelagic waters, regardless of their depth or distance from the coast.

2. This sovereignty extends to the air space over the archipelagic waters, as well as to their bed and subsoil, and the resources contained therein.

3. This sovereignty is exercised subject to this Part.

4. The régime of archipelagic sea lanes passage established in this Part shall not in other respects affect the status of the archipelagic waters, including the sea lanes, or the exercise by the archipelagic State of its sovereignty over such waters and their air space, bed and subsoil, and the resources contained therein.

Article 50
Delimitation of internal waters

Within its archipelagic waters, the archipelagic State may draw closing lines for the delimitation of internal waters, in accordance with articles 9, 10 and 11.

Article 51
Existing agreements, traditional fishing rights and existing submarine cables

1. Without prejudice to article 49, an archipelagic State shall respect existing agreements with other States and shall recognize traditional fishing rights and other legitimate activities of the immediately adjacent neighbouring States in certain areas falling within archipelagic waters. The terms and conditions for the exercise of such rights and activities, including the nature, the extent and the areas to which they apply, shall, at the request of any of the States concerned, be regulated by bilateral agreements, between them. Such rights shall not be transferred to or shared with third States or their nationals.

2. An archipelagic State shall respect existing submarine cables laid by other States and passing through its waters without making a landfall. An archipelagic State shall permit the maintenance and replacement of such cables upon receiving due notice of their location and the intention to repair or replace them.

Article 52
Right of innocent passage

1. Subject to article 53 and without prejudice to article 50, ships of all States enjoy the right of innocent passage through archipelagic waters, in accordance with Part II, section 3.

2. The archipelagic State may, without discrimination in form or in fact among foreign ships, suspend temporarily in specified areas of its archipelagic waters the innocent passage of foreign ships if such suspension is essential for the protection of its security. Such suspension shall take effect only after having been duly published.

Article 53
Right of archipelagic sea lanes passage

1. An archipelagic State may designate sea lanes and air routes there above, suitable for the continuous and expeditious passage of foreign ships and aircraft through or over its archipelagic waters and the adjacent territorial sea.

2. All ships and aircraft enjoy the right of archipelagic sea lanes passage in such sea lanes and air routes.

3. Archipelagic sea lanes passage means the exercise in accordance with this Convention of the rights of navigation and over flight in the normal mode solely for the purpose of continuous, expeditious and unobstructed transit between one part of the high seas or an exclusive economic zone and another part of the high seas or an exclusive economic zone.

4. Such sea lanes and air routes shall traverse the archipelagic waters and the adjacent territorial sea and shall include all normal passage routes used as routes for international navigation or over flight through or over archipelagic waters and, within such routes, so far as ships are concerned, all normal navigational channels, provided

that duplication of routes of similar convenience between the same entry and exit points shall not be necessary.

5. Such sea lanes and air routes shall be defined by a series of continuous axis lines from the entry points of passage routes to the exit points. Ships and aircraft in archipelagic sea lanes passage shall not deviate more than 25 nautical miles to either side of such axis lines during passage, provided that such ships and aircraft shall not navigate closer to the coasts than 10 per cent of the distance between the nearest points on islands bordering the sea lane.

6. An archipelagic State which designates sea lanes under this article may also prescribe traffic separation schemes for the safe passage of ships through narrow channels in such sea lanes.

7. An archipelagic State may, when circumstances require, after giving due publicity thereto, substitute other sea lanes or traffic separation schemes for any sea lanes or traffic separation schemes previously designated or prescribed by it.

8. Such sea lanes and traffic separation schemes shall conform to generally accepted international regulations.

9. In designating or substituting sea lanes or prescribing or substituting traffic separation schemes, an archipelagic State shall refer proposals to the competent international organization with a view to their adoption. The organization may adopt only such sea lanes and traffic separation schemes as may be agreed with the archipelagic State, after which the archipelagic State may designate, prescribe or substitute them.

10. The archipelagic State shall clearly indicate the axis of the sea lanes and the traffic separation schemes designated or prescribed by it on charts to which due publicity shall be given.

11. Ships in archipelagic sea lanes passage shall respect applicable sea lanes and traffic separation schemes established in accordance with this article.

12. If an archipelagic State does not designate sea lanes or air routes, the right of archipelagic sea lanes passage may be exercised through the routes normally used for international navigation.

Article 54
Duties of ships and aircraft during their passage, research and survey activities, duties of the archipelagic State and laws and regulations of the archipelagic State relating to archipelagic sea lanes passage

Articles 39, 40, 42 and 44 apply **mutatis mutandis** to archipelagic sea lanes passage.

PART V

EXCLUSIVE ECONOMIC ZONE

Article 55
Specific legal régime of the exclusive economic zone

The exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to the specific legal régime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States are governed by the relevant provisions of this Convention.

Article 56
Rights, jurisdiction and duties of the coastal State in the exclusive economic zone

1. In the exclusive economic zone, the coastal State has:

   (a) sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the sea-bed and of the sea-bed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds;

   (b) jurisdiction as provided for in the relevant provisions of this Convention with regard to:

      (i) the establishment and use of artificial islands, installations and structures;

      (ii) marine scientific research;

      (iii) the protection and preservation of the marine environment;

   (c) other rights and duties provided for in this Convention.

2. In exercising its rights and performing its duties under this Convention in the exclusive economic zone, the coastal State shall have due regard to the rights and duties of other States and shall act in a manner compatible with the provisions of this Convention.

3. The rights set out in this article with respect to the sea-bed and subsoil shall be exercised in accordance with Part VI.

Article 57
Breadth of the exclusive economic zone

The exclusive economic zone shall not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

Article 58
Rights and duties of other States in the exclusive economic zone

1. In the exclusive economic zone, all States, whether coastal or land-locked, enjoy, subject to the relevant provisions of this Convention, the freedoms referred to in article 87 of navigation and over flight and of the laying of submarine cables and pipelines, and other internationally lawful uses of the sea related to these freedoms, such as those associated with the operation of ships, aircraft and submarine cables and pipelines, and compatible with the other provisions of this Convention.

2. Articles 88 to 115 and other pertinent rules of international law apply to the exclusive economic zone in so far as they are not incompatible with this Part.

3. In exercising their rights and performing their duties under this Convention in the exclusive economic zone, States shall have due regard to the rights and duties of the coastal State and shall comply with the laws and regulations adopted by the coastal State in accordance with the provisions of this Convention and other rules of international law in so far as they are not incompatible with this Part.

Article 59
Basis for the resolution of conflicts regarding the attribution of rights and jurisdiction in the exclusive economic zone

In cases where this Convention does not attribute rights or jurisdiction to the coastal State or to other States within the exclusive economic zone, and a conflict arises between the interests of the coastal State and any other State or States, the conflict should be resolved on the basis of equity and in the light of all the relevant circumstances, taking into account the respective importance of the interests involved to the parties as well as to the international community as a whole.

Article 60
Artificial islands, installations and structures in the exclusive economic zone

1. In the exclusive economic zone, the coastal State shall have the exclusive right to construct and to authorize and regulate the construction, operation and use of:

(a) artificial islands;

(b) installations and structures for the purposes provided for in article 56 and other economic purposes;

(c) installations and structures which may interfere with the exercise of the rights of the coastal State in the zone.

2. The coastal State shall have exclusive jurisdiction over such artificial islands, installations and structures, including jurisdiction with regard to customs, fiscal, health, safety and immigration laws and regulations.

3. Due notice must be given of the construction of such artificial islands, installations or structures, and permanent means for giving warning of their presence

must be maintained. Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organization. Such removal shall also have due regard to fishing, the protection of the marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed.

4. The coastal State may, where necessary, establish reasonable safety zones around such artificial islands, installations and structures in which it may take appropriate measures to ensure the safety both of navigation and of the artificial islands, installations and structures.

5. The breadth of the safety zones shall be determined by the coastal State, taking into account applicable international standards. Such zones shall be designed to ensure that they are reasonably related to the nature and function of the artificial islands, installations or structures, and shall not exceed a distance of 500 metres around them, measured from each point of their outer edge, except as authorized by generally accepted international standards or as recommended by the competent international organizations. Due notice shall be given of the extent of safety zones.

6. All ships must respect these safety zones and shall comply with generally accepted international standards regarding navigation in the vicinity of artificial islands, installations, structures and safety zones.

7. Artificial islands, installations and structures and the safety zones around them may not be established where interference may be caused to the use of recognized sea lanes essential to international navigation.

8. Artificial islands, installations and structures do not possess the status of islands. They have no territorial sea of their own, and their presence does not affect the delimitation of the territorial sea, the exclusive economic zone or the continental shelf.

Article 61
Conservation of the living resources

1. The coastal State shall determine the allowable catch of the living resources in its exclusive economic zone.

2. The coastal State, taking into account the best scientific evidence available to it, shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation. As appropriate, the coastal State and competent international organizations, whether sub regional, regional or global, shall co-operate to this end.

3. Such measures shall also be designated to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors, including the economic needs of coastal fishing communities and the special requirements of developing

States, and taking into account fishing patterns, the interdependence of stocks and any generally recommended international minimum standards, whether sub regional, regional or global.

4. In taking such measures the coastal State shall take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened.

5. Available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis through competent international organizations, whether sub regional, regional or global, where appropriate and with participation by all States concerned, including States whose nationals are allowed to fish in the exclusive economic zone.

Article 62
Utilization of the living resources

1. The coastal State shall promote the objective of optimum utilization of the living resources in the exclusive economic zone without prejudice to article 61.

2. The coastal State shall determine its capacity to harvest the living resources of the exclusive economic zone. Where the coastal State does not have the capacity to harvest the entire allowable catch, it shall, through agreements or other arrangements and pursuant to the terms, conditions laws and regulations referred to in paragraph 4, give other States access to the surplus of the allowable catch, having particular regard to the provisions of articles 69 and 70, especially in relation to the developing States mentioned therein.

3. In giving access to other States to its exclusive economic zone under this article, the coastal State shall take into account all relevant factors, including, **inter alia**, the significance of the living resources of the area to the economy of the coastal State concerned and its other national interests, the provisions of article 69 and 70, the requirements of developing States in the sub region or region in harvesting part of the surplus and the need to minimize economic dislocation in States whose nationals have habitually fished in the zone or which have made substantial efforts in research and identification of stocks.

4. Nationals of other States fishing in the exclusive economic zone shall comply with the conservation measures and with the other terms and conditions established in the laws and regulations of the coastal State. These laws and regulations shall be consistent with this Convention and may relate, **inter alia**, to the following:

(a) licensing of fishermen, fishing vessels and equipment, including payment of fees and other forms or remuneration, which, in the case of developing coastal States, may consist of adequate compensation in the field of financing, equipment and technology relating to the fishing industry;

(b) determining the species which may be caught, and fixing quotas of catch, whether in relation to particular stocks or groups of stocks or catch per vessel over a period of time or to the catch by nationals of any State during a specified period;

(c) regulating seasons and areas of fishing, the types, sizes and amount of gear, and the types, sizes and number of fishing vessels that may be used;

(d) fixing the age and size of fish and other species that may be caught;

(e) specifying information required of fishing vessels, including catch and effort statistics and vessel position reports;

(f) requiring, under the authorization and control of the coastal State, the conduct of such research, including the sampling of catches, disposition of samples and reporting of associated scientific data;

(g) the placing of observers or trainees on board such vessels by the coastal State;

(h) the landing of all or any part of the catch by such vessels in the ports of the coastal State;

(i) terms and conditions relating to joint ventures or other co-operative arrangements;

(j) requirements for the training of personnel and the transfer of fisheries technology, including enhancement of the coastal State's capability of undertaking fisheries research;

(k) enforcement procedures.

5. Coastal States shall give due notice of conservation and management laws and regulations.

Article 63
Stocks occurring within the exclusive economic zone of two or more coastal States or both within the exclusive economic zone and in an area beyond and adjacent to it

1. Where the same stock or stocks of associated species occur within the exclusive economic zone of two or more coastal States, these States shall seek, either directly or through appropriate sub regional or regional organizations, to agree upon the measures necessary to co-ordinate and ensure the conservation and development of such stocks without prejudice to the other provisions of this Part.

2. Where the same stock or stocks of associated species occur both within the exclusive economic zone and in an area beyond and adjacent to the zone, the coastal State and the States fishing for such stocks in the adjacent area shall seek, either

directly or through appropriate sub regional or regional organizations, to agree upon the measures necessary for the conservation of these stocks in the adjacent area.

Article 64
Highly migratory species

1. The coastal State and other States whose nationals fish in the region for the highly migratory species listed in Annex I shall co-operate directly or through appropriate international organizations with a view to ensuring conservation and promoting the objective of optimum utilization of such species throughout the region, both within and beyond the exclusive economic zone. In regions for which, no appropriate international organization exists, the coastal State and other States whose nationals harvest these species in the region shall co-operate to establish such an organization and participate in its work.

2. The provisions of paragraph 1 apply in addition to the other provisions of this Part.

Article 65
Marine mammals

Nothing in this Part restricts the right of a coastal State or the competence of an international organization, as appropriate, to prohibit, limit or regulate the exploitation of marine mammals more strictly than provided for in this Part. States shall co-operate with a view to the conservation of marine mammals and in the case of cetaceans shall in particular work through the appropriate international organizations for their conservation, management and study.

Article 66
Anadromous stocks

1. States in whose rivers anadromous stocks originate shall have the primary interest in and responsibility for such stocks.

2. The State of origin of anadromous stocks shall ensure their conservation by the establishment of appropriate regulatory measures for fishing in all waters landward of the outer limits of its exclusive economic zone and for fishing provided for in paragraph 3(b). The State or origin may, after consultations with the other States referred to in paragraphs 3 and 4 fishing these stocks, establish total allowable catches for stocks originating in its rivers.

3. (a) Fisheries for anadromous stocks shall be conducted only in waters landward of the outer limits of exclusive economic zones, except in cases where this provision would result in economic dislocation for a State other than the State of origin. With respect to such fishing beyond the outer limits of the exclusive economic zone, States concerned shall maintain consultations with a view to achieving agreement on terms and conditions of such fishing giving due regard to the conservation requirements and the needs of the State of origin in respect of these stocks.

(b) The State of origin shall co-operate in minimizing economic dislocation in such other States fishing these stocks, taking into account the normal catch and the mode of operations of such States, and all the areas in which such fishing has occurred.

(c) States referred to in subparagraph (b), participating by agreement with the State of origin in measures to renew anadromous stocks, particularly by expenditures for that purpose, shall be given special consideration by the State of origin in the harvesting of stocks originating in its rivers.

(d) Enforcement of regulations regarding anadromous stocks beyond the exclusive economic zone shall be by agreement between the State of origin and the other States concerned.

4. In cases where anadromous stocks migrate into or through the waters landward of the outer limits of the exclusive economic zone of a State other than the State of origin, such State shall co-operate with the State of origin with regard to the conservation and management of such stocks.

5. The State of origin of anadromous stocks and other States fishing these stocks shall make arrangements for the implementation of the provisions of this article, where appropriate, through regional organizations.

Article 67
Catadromous species

1. A coastal State in whose waters catadromous species spend the greater part of their life cycle shall have responsibility for the management of these species and shall ensure the ingress and egress of migrating fish.

2. Harvesting of catadromous species shall be conducted only in waters landward of the outer limits of exclusive economic zones. When conducted in exclusive economic zones, harvesting shall be subject to this article and the other provisions of this Convention concerning fishing in these zones.

3. In cases where catadromous fish migrate through the exclusive economic zone of another State, whether as juvenile or maturing fish, the management, including harvesting, of such fish shall be regulated by agreement between the State mentioned in paragraph 1 and the other States concerned. Such agreement shall ensure the rational management of the species and take into account the responsibilities of the State mentioned in paragraph 1 for the maintenance of these species.

Article 68
Sedentary species

This Part does not apply to sedentary species as defined in article 77, paragraph 4.

Article 69
Right of land-locked States

1. Land-locked States shall have the right to participate, on an equitable basis, in the exploitation of an appropriate part of the surplus of the living resources of the exclusive economic zones of coastal States of the same sub region or region, taking into account the relevant economic and geographical circumstances of all the States concerned and in conformity with the provisions of this article and of articles 61 and 62.

2. The terms and modalities of such participation shall be established by the States concerned through bilateral, sub regional or regional agreements taking into account, **inter alia**:

(a) the need to avoid effects detrimental to fishing communities or fishing industries of the coastal State;

(b) the extent to which the land-locked State, in accordance with the provisions of this article, is participating or is entitled to participate under existing bilateral, sub regional or regional agreements in the exploitation of living resources of the exclusive economic zones of other coastal States;

(c) the extent to which other land-locked States and geographically disadvantaged States are participating in the exploitation of the living resources of the exclusive economic zone of the coastal State and the consequent need to avoid a particular burden for any single coastal State or a part of it;

(d) the nutritional needs of the populations of the respective States.

3. When the harvesting capacity of a coastal State approaches a point which would enable it to harvest the entire allowable catch of the living resources in its exclusive economic zone, the coastal State and other States concerned shall co-operate in the establishment of equitable arrangements on a bilateral, sub regional or regional basis to allow for participation of developing land-locked States of the same sub region or region in the exploitation of the living resources of the exclusive economic zones of coastal States of the sub region or region, as may be appropriate in the circumstances and on terms satisfactory to all parties. In the implementation of this provision the factors mentioned in paragraph 2 shall also be taken into account.

4. Developed land-locked States shall, under the provisions of this article, be entitled to participate in the exploitation of living resources only in the exclusive economic zones of developed coastal States of the same sub region or region having regard to the extent to which the coastal State, in giving access to other States to the

living resources of its exclusive economic zone, has taken into account the need to minimize detrimental effects on fishing communities and economic dislocation in States whose nationals have habitually fished in the zone.

5. The above provisions are without prejudice to arrangements agreed upon in sub regions or regions where the coastal States may grant to land-locked States of the same sub region or region equal or preferential rights for the exploitation of the living resources in the exclusive economic zones.

Article 70
Right of geographically disadvantaged States

1. Geographically disadvantaged States shall have the right to participate, on an equitable basis, in the exploitation of an appropriate part of the surplus of the living resources of the exclusive economic zones of coastal States of the same sub region or region, taking into account the relevant economic and geographical circumstances of all the states concerned and in conformity with the provisions of this article and of articles 61 and 62.

2. For the purposes of this Part, "geographically disadvantaged States" means coastal States, including States bordering enclosed or semi-enclosed seas, whose geographical situation makes them dependent upon the exploitation of the living resources of the exclusive economic zones of other states in the sub region or region for adequate supplies of fish for the nutritional purposes of their populations or parts thereof, and coastal States which can claim no exclusive economic zones of their own.

3. The terms and modalities of such participation shall be established by the States concerned through bilateral, sub regional or regional agreements taking into account, **inter alia**:

(a) the need to avoid effects detrimental to fishing communities or fishing industries of the coastal State;

(b) the extent to which the geographically disadvantaged State, in accordance with the provisions of this article, is participating or is entitled to participate under existing bilateral, sub regional or regional agreements in the exploitation of living resources of the exclusive economic zones of other coastal States;

(c) the extent to which other geographically disadvantaged States and land-locked States are participating in the exploitation of the living resources of the exclusive economic zone of the coastal State and the consequent need to avoid a particular burden for any single coastal State or a part of it;

(d) the nutritional needs of the populations of the respective States.

4. When the harvesting capacity of a coastal State approaches a point which would enable it to harvest the entire allowable catch of the living resources in its

exclusive economic zone, the coastal State and other States concerned shall co-operate in the establishment of equitable arrangements on a bilateral, sub regional or regional basis to allow for participation of developing geographically disadvantaged States of the same sub region or region in the exploitation of the living resources of the exclusive economic zones of coastal States of the sub region or region, as may be appropriate in the circumstances and on terms satisfactory to all parties. In the implementation of this provision the factors mentioned in paragraph 3 shall also be taken into account.

5. Developed geographically disadvantaged States shall, under the provisions of this article, be entitled to participate in the exploitation of living resources only in the exclusive economic zones of developed coastal States of the same sub region or region having regard to the extent to which the coastal State, in giving access to other States to the living resources of its exclusive economic zone, has taken into account the need to minimize detrimental effects on fishing communities and economic dislocation in States whose nationals have habitually fished in the zone.

6. The above provisions are without prejudice to arrangements agreed upon in sub regions or regions where the coastal States may grant to geographically disadvantaged States of the same sub region or region equal or preferential rights for the exploitation of the living resources in the exclusive economic zones.

Article 71
Non-applicability of articles 69 and 70

The provisions of articles 69 and 70 do not apply in the case of a coastal State whose economy is overwhelmingly dependent on the exploitation of the living resources of its exclusive economic zone.

Article 72
Restrictions on transfer of rights

1. Rights provided under articles 69 and 70 to exploit living resources shall not be directly or indirectly transferred to third States or their nationals by lease or licence, by establishing joint ventures or in any other manner which has the effect of such transfer unless otherwise agreed by the States concerned.

2. The foregoing provision does not preclude the States concerned from obtaining technical or financial assistance from third States or international organizations in order to facilitate the exercise of the rights pursuant to articles 69 and 70, provided that it does not have the effect referred to in paragraph 1.

Article 73
Enforcement of laws and regulations of the coastal State

1. The coastal State may, in the exercise of its sovereign rights to explore, exploit, conserve and manage the living resources in the exclusive economic zone, take such measures, including boarding, inspection, arrest and judicial proceedings, as may be necessary to ensure compliance with the laws and regulations adopted by it in conformity with this Convention.

2. Arrested vessels and their crews shall be promptly released upon the posting of reasonable bond or other security.

3. Coastal State penalties for violations of fisheries laws and regulations in the exclusive economic zone may not include imprisonment, in the absence of agreements to the contrary by the States concerned, or any other form of corporal punishment.

4. In cases of arrest or detention of foreign vessels the coastal State shall promptly notify the flag State, through appropriate channels, of the action taken and of any penalties subsequently imposed.

Article 74
Delimitation of the exclusive economic zones between States with opposite or adjacent coasts

1. The delimitation of the exclusive economic zone between States with opposite or adjacent coasts shall be effected by agreement on the basis of international law, as referred in Article 38 of the Statute of the International Court of Justice, in order to achieve an equitable solution.

2. If no agreement can be reached within a reasonable period of time, the States concerned shall resort to the procedures provided for in Part XV.

3. Pending agreement as provided for in paragraph 1, the States concerned, in a spirit of understanding and co-operation, shall make every effort to enter into provisional arrangements of a practical nature and, during this transitional period, not to jeopardize or hamper the reaching of the final agreement. Such arrangements shall be without prejudice to the final delimitation.

4. Where there is an agreement in force between the States concerned, questions relating to the delimitation of the exclusive economic zone shall be determined in accordance with the provisions of that agreement.

Article 75
Charts and lists of geographical co-ordinates

1. Subject to this Part, the outer limit lines of the exclusive economic zone and the lines of delimitation drawn in accordance with article 74 shall be shown on charts of a scale or scales adequate for ascertaining their position. Where appropriate, lists of geographical co-ordinates of points, specifying the geodetic datum, may be substituted for such outer limit lines or lines of delimitation.

2. The coastal State shall give due publicity to such charts or lists of geographical co-ordinates and shall deposit a copy of each such chart or list with the Secretary-General of the United Nations.

PART VI

CONTINENTAL SHELF

Article 76
Definition of the continental shelf

1. The continental shelf of a coastal State comprises the sea-bed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extent up to that distance.

2. The continental shelf of a coastal State shall not extend beyond the limits provided for in paragraphs 4 to 6.

3. The continental margin comprises the submerged prolongation of the land mass of the coastal State, and consists of the sea-bed and subsoil of the shelf, the slope and the rise. It does not include the deep ocean floor with its oceanic ridges or the subsoil thereof.

4. (a) For the purposes of this Convention, the coastal State shall establish the outer edge of the continental margin wherever the margin extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, by either:

   (i) a line delineated in accordance with paragraph 7 by reference to the outermost fixed points at each of which the thickness of sedimentary rocks is at least 1 per cent of the shortest distance from such point to the foot of the continental slope; or

   (ii) a line delineated in accordance with paragraph 7 by reference to fixed points not more than 60 nautical miles from the foot of the continental slope.

   (b) In the absence of evidence to the contrary, the foot of the continental slope shall be determined as the point of maximum change in the gradient as its base.

5. The fixed points comprising the line of the outer limits of the continental shelf on the sea-bed, drawn in accordance with paragraph 4 (a)(i) and (ii), either shall not exceed 350 nautical miles from the baselines from which the breadth of the territorial sea is measured or shall not exceed 100 nautical miles from the 2,500 metre isobath, which is a line connecting the depth of 2,500 metres.

6. Notwithstanding the provisions of paragraph 5, on submarine ridges, the outer limit of the continental shelf shall not exceed 350 nautical miles from the baselines from which the breadth of the territorial sea is measured. This paragraph

does not apply to submarine elevations that are natural components of the continental margin, such as its plateaux, rises, caps, banks and spurs.

7. The coastal State shall delineate the outer limits of its continental shelf, where that shelf extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, by straight lines not exceeding 60 nautical miles in length, connecting fixed points, defined by co-ordinates of latitude and longitude.

8. Information on the limits of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured shall be submitted by the coastal State to the Commission on the Limits of the Continental Shelf set up under Annex II on the basis of equitable geographical representation. The Commission shall make recommendations to coastal States on matters related to the establishment of the outer limits of their continental shelf. The limits of the shelf established by a coastal State on the basis of these recommendations shall be final and binding.

9. The coastal State shall deposit with the Secretary-General of the United Nations charts and relevant information, including geodetic data, permanently describing the outer limits of its continental shelf. The Secretary-General shall give due publicity thereto.

10. The provisions of this article are without prejudice to the question of delimitation of the continental shelf between States with opposite or adjacent coasts.

Article 77
Rights of the coastal State over the continental shelf

1. The coastal State exercises over the continental shelf sovereign rights for the purpose of exploring it and exploiting its natural resources.

2. The rights referred to in paragraph 1 are exclusive in the sense that if the coastal State does not explore the continental shelf or exploit its natural resources, no one may undertake these activities without the express consent of the coastal State.

3. The rights of the coastal State over the continental shelf do not depend on occupation, effective or notional, or on any express proclamation.

4. The natural resources referred to in this Part consist of the mineral and other non-living resources of the sea-bed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the sea-bed or are unable to move except in constant physical contact with the sea-bed or the subsoil.

Article 78
Legal status of the superjacent waters and air space and the rights and freedoms of other States

1. The rights of the coastal State over the continental shelf do not affect the legal status of the superjacent waters or of the air space above those waters.

2. The exercise of the rights of the coastal State over the continental shelf must not infringe or result in any unjustifiable interference with navigation and other rights and freedoms of other States as provided for in this Convention.

Article 79
Submarine cables and pipelines on the continental shelf

1. All States are entitled to lay submarine cables and pipelines on the continental shelf, in accordance with the provisions of this article.

2. Subject to its right to take reasonable measures for the exploration of the continental shelf, the exploitation of its natural resources and the prevention, reduction and control of pollution from pipelines, the coastal State may not impede the laying or maintenance of such cables or pipelines.

3. The delineation of the course for the laying of such pipelines on the continental shelf is subject to the consent of the coastal State.

4. Nothing in this Part affects the right of the coastal State to establish conditions for cables or pipelines entering its territory or territorial sea, or its jurisdiction over cables and pipelines constructed or used in connection with the exploration of its continental shelf or exploitation of its resources or the operations of artificial islands, installations and structures under its jurisdiction.

5. When laying submarine cables or pipelines, States shall have due regard to cables or pipelines already in position. In particular, possibilities of repairing existing cables or pipelines shall not be prejudiced.

Article 80
Artificial islands, installations and structures on the continental shelf

Article 60 applies **mutatis mutandis** to artificial islands, installations and structures on the continental shelf.

Article 81
Drilling on the continental shelf

The coastal State shall have the exclusive right to authorize and regulate drilling on the continental shelf for all purposes.

Article 82
Payments and contributions with respect to the exploitation of the continental shelf beyond 200 nautical miles

1. The coastal State shall make payments or contributions in kind in respect of the exploitation of the non-living resources of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

2. The payments and contributions shall be made annually with respect to all production at a site after the first five years of production at that site. For the sixth year, the rate of payment or contribution shall be 1 per cent of the value or volume of production at the site. The rate shall increase by 1 per cent for each subsequent year until the twelfth year and shall remain at 7 per cent thereafter. Production does not include resources used in connection with exploitation.

3. A developing State which is a net importer of a mineral resource produced from its continental shelf is exempt from making such payments or contributions in respect of that mineral resource.

4. The payments or contributions shall be made through the Authority, which shall distribute them to States parties to this Convention, on the basis of equitable sharing criteria, taking into account the interests and needs of developing States, particularly the least developed and the land-locked among them.

Article 83
Delimitation of the continental shelf between States with opposite or adjacent coasts

1. The delimitation of the continental shelf between States with opposite or adjacent coasts shall be effected by agreement on the basis of international law, as referred to in Article 38 of the Statute of the International Court of Justice, in order to achieve an equitable solution.

2. If no agreement can be reached within a reasonable period of time, the States concerned shall resort to the procedures provided for in Part XV.

3. Pending agreement as provided for in paragraph 1, the States concerned, in a spirit of understanding and co-operation, shall make every effort to enter into provisional arrangements of a practical nature and, during this transitional period, not to jeopardize or hamper the reaching of the final agreement. Such arrangements shall be without prejudice to the final delimitation.

4. Where there is an agreement in force between the States concerned, questions relating to the delimitation of the continental shelf shall be determined in accordance with the provisions of that agreement.

Article 84
Charts and lists of geographical co-ordinates

1. Subject to this Part, the outer limit lines of the continental shelf and the lines of delimitation drawn in accordance with article 83 shall be shown on charts of a scale or scales adequate for ascertaining their position. Where appropriate, lists of geographical co-ordinates of points, specifying the geodetic datum, may be substituted for such outer limit lines or lines of delimitation.

2. The coastal State shall give due publicity to such charts or lists of geographical co-ordinates and shall deposit a copy of each such chart or list with the Secretary-General of the United Nations and, in the case of those showing the outer limit lines of the continental shelf, with the Secretary-General of the Authority.

Article 85
Tunnelling

This Part does not prejudice the right of the coastal State to exploit the subsoil by means of tunnelling, irrespective of the depth of water above the subsoil.

PART VII

HIGH SEAS

SECTION 1. GENERAL PROVISIONS

Article 86
Application of the provisions of this Part

The provisions of this Part apply to all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State. This article does not entail any abridgement of the freedoms enjoyed by all States in the exclusive economic zone in accordance with article 58.

Article 87
Freedom of the high seas

1. The high seas are open to all States, whether coastal or land-locked. Freedom of the high seas is exercised under the conditions laid down by this Convention and by other rules of international law. It comprises, **inter alia**, both for coastal and land-locked States:

(a) freedom of navigation;

(b) freedom of over flight;

(c) freedom to lay submarine cables and pipelines, subject to Part VI;

(d) freedom to construct artificial islands and other installations permitted under international law, subject to Part VI;

(e) freedom of fishing, subject to the conditions laid down in section 2;

(f) freedom of scientific research, subject to Parts VI and XIII.

2. These freedoms shall be exercised by all States with due regard for the interests of other States in their exercise of the freedom of the high seas, and also with due regard for the rights under this Convention with respect to activities in the Area.

Article 88
Reservation of the high seas for peaceful purposes

The high seas shall be reserved for peaceful purposes.

Article 89
Invalidity of claims of sovereignty over the high seas

No State may validly purport to subject any part of the high seas to its sovereignty.

Article 90
Right of navigation

Every State, whether coastal or land-locked, has the right to sail ships flying its flag on the high seas.

Article 91
Nationality of ships

1. Every State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the State whose flag they are entitled to fly. There must exist a genuine link between the State and the ship.

2. Every State shall issue to ships to which it has granted the right to fly its flag documents to that effect.

Article 92
Status of ships

1. Ships shall sail under the flag of one State only and, save in exceptional cases expressly provided for in international treaties or in this Convention, shall be subject to its exclusive jurisdiction on the high seas. A ship may not change its flag during a voyage or while in a port of call, save in the case of a real transfer of ownership or change of registry.

2. A ship which sails under the flags of two or more States, using them according to convenience, may not claim any of the nationalities in question with respect to any other State, and may be assimilated to a ship without nationality.

Article 93
Ships flying the flag of the United Nations, its specialized agencies and the International Atomic Energy Agency

The preceding articles do not prejudice the question of ships employed on the official service of the United Nations, its specialized agencies or the International Atomic Energy Agency, flying the flag of the organization.

Article 94
Duties of the flag State

1. Every State shall effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag.

2. In particular every State shall:

(a) maintain a register of ships containing the names and particulars of ships flying its flag, except those which are excluded from generally accepted international regulations on account of their small size; and

(b) assume jurisdiction under its internal law over each ship flying its flag and its master, officers and crew in respect of administrative, technical and social matters concerning the ship.

3. Every State shall take such measures for ships flying its flag as are necessary to ensure safety at sea with regard, **inter alia**, to:

(a) the construction, equipment and seaworthiness of ships;

(b) the manning of ships, labour conditions and the training of crews, taking into account the applicable international instruments;

(c) the use of signals, the maintenance of communications and the prevention of collisions.

4. Such measures shall include those necessary to ensure:

(a) that each ship, before registration and thereafter at appropriate intervals, is surveyed by a qualified surveyor of ships, and has on board such charts, nautical publications and navigational equipment and instruments as are appropriate for the safe navigation of the ship;

(b) that each ship is in the charge of a master and officers who possess appropriate qualifications, in particular in seamanship, navigation, communications and marine engineering, and that the crew is appropriate in qualification and numbers for the type, size, machinery and equipment of the ship;

(c) that the master, officers and, to the extent appropriate, the crew are fully conversant with and required to observe the applicable international regulations concerning the safety of life at sea, the prevention of collisions, the prevention, reduction and control of marine pollution, and the maintenance of communications by radio.

5. In taking the measures called for in paragraphs 3 and 4 each State is required to conform to generally accepted international regulations, procedures and practices and to take any steps which may be necessary to secure their observance.

6. A State which has clear grounds to believe that proper jurisdiction and control with respect to a ship have not been exercised may report the facts to the flag State. Upon receiving such a report, the flag State shall investigate the matter and, if appropriate, take any action necessary to remedy the situation.

7. Each State shall cause an inquiry to be held by or before a suitably qualified person or persons into every marine casualty or incident of navigation on the high seas involving a ship flying its flag and causing loss of life or serious injury to nationals of another State or serious damage to ships or installations of another State or to the marine environment. The flag State and the other State shall co-operate in the conduct of any inquiry held by that other State into any such marine casualty or incident of navigation.

Article 95
Immunity of warships on the high seas

Warships on the high seas have complete immunity from the jurisdiction of any State other than the flag State.

Article 96
Immunity of ships used only on government non-commercial service

Ships owned or operated by a State and used only on government non-commercial service shall, on the high seas, have complete immunity from the jurisdiction of any State other than the flag State.

Article 97
Penal jurisdiction in matters of collision or any other incident of navigation

1. In the event of a collision or any other incident of navigation concerning a ship on the high seas, involving the penal or disciplinary responsibility of the master or of any other person in the service of the ship, no penal or disciplinary proceedings may be instituted against such person except before the judicial or administrative authorities either of the flag State or of the State of which such person is a national.

2. In disciplinary matters, the State which has issued a master's certificate or a certificate of competence or licence shall alone be competent, after due legal process, to pronounce the withdrawal of such certificates, even if the holder is not a national of the State which issued them.

3. No arrest or detention of the ship, even as a measure of investigation, shall be ordered by any authorities other than those of the flag State.

Article 98
Duty to render assistance

1. Every State shall require the master of a ship flying its flag, in so far as he can do so without serious danger to the ship, the crew or the passengers:

(a) to render assistance to any person found at sea in danger of being lost;

(b) to proceed with all possible speed to the rescue of persons in distress, if informed of their need of assistance, in so far as such action may reasonably be expected of him;

(c) after a collision, to render assistance to the other ship, its crew and its passengers and, where possible, to inform the other ship of the name of his own ship, its port of registry and the nearest port at which it will call.

2. Every coastal State shall promote the establishment, operation and maintenance of an adequate and effective search and rescue service regarding safety

on and over the sea and, where circumstances so require, by way of mutual regional arrangements co-operate with neighbouring States for this purpose.

Article 99
Prohibition of the transport of slaves

Every State shall take effective measures to prevent and punish the transport of slaves in ships authorized to fly its flag and to prevent the unlawful use of its flag for that purpose. Any slave taking refuge on board any ship, whatever its flag, shall **ipso facto** be free.

Article 100
Duty to co-operate in the repression of piracy

All States shall co-operate to the fullest possible extent in the repression of piracy on the high seas or in any other place outside the jurisdiction of any State.

Article 101
Definition of piracy

Piracy consists of any of the following acts:

(a) any illegal acts of violence or detention, or any act of depredation committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed:

(i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;

(ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

(b) any act of voluntary participation in the operation of a ship, or an aircraft with knowledge of facts making it a pirate ship or aircraft;

(c) any act of inciting or of intentionally facilitating an act described in sub-paragraph (a) or (b).

Article 102
Piracy by a warship, government ship or government aircraft whose crew has mutinied

The acts of piracy, as defined in article 101, committed by a warship, government ship or government aircraft whose crew has mutinied and taken control of the ship or aircraft are assimilated to acts committed by a private ship or aircraft.

Article 103
Definition of a pirate ship or aircraft

A ship or aircraft is considered a pirate ship or aircraft if it is intended by the persons in dominant control to be used for the purpose of committing one of the acts referred to in article 101. The same applies if the ship or aircraft has been used to commit any such act, so long as it remains under the control of the persons guilty of that act.

Article 104
Retention or loss of the nationality of a pirate ship or aircraft

A ship or aircraft may retain its nationality although it has become a pirate ship or aircraft. The retention or loss of nationality is determined by the law of the State from which such nationality was derived.

Article 105
Seizure of a pirate ship or aircraft

On the high seas, or in any other place outside the jurisdiction of any State, every State may seize a pirate ship or aircraft, or a ship or aircraft taken by piracy and under the control of pirates, and arrest the persons and seize the property on board. The courts of the State which carried out the seizure may decide upon the penalties to be imposed, and may also determine the action to be taken with regard to the ships, aircraft or property, subject to the rights of third parties acting in good faith.

Article 106
Liability for seizure without adequate grounds

Where the seizure of a ship or aircraft on suspicion of piracy has been effected without adequate grounds, the State making the seizure shall be liable to the State the nationality of which is possessed by the ship or aircraft for any loss or damage caused by the seizure.

Article 107
Ships and aircraft which are entitled to seize on account of piracy

A seizure on account of piracy may be carried out only by warships or military aircraft, or other ships or aircraft clearly marked and identifiable as being on government service and authorized to that effect.

Article 108
Illicit traffic in narcotic drugs or psychotropic substances

1. All States shall co-operate in the suppression of illicit traffic in narcotic drugs and psychotropic substances engaged in by ships on the high seas contrary to international conventions.

2. Any State which has reasonable grounds for believing that a ship flying its flag is engaged in illicit traffic in narcotic drugs or psychotropic substances may request the co-operation of other States to suppress such traffic.

Article 109
Unauthorized broadcasting from the high seas

1. All States shall co-operate in the suppression of unauthorized broadcasting from the high seas.

2. For the purposes of this Convention, "unauthorized broadcasting" means the transmission of sound radio or television broadcasts from a ship or installation on the high seas intended for reception by the general public contrary to international regulations, but excluding the transmission of distress calls.

3. Any person engaged in unauthorized broadcasting may be prosecuted before the court of:

(a) the flag State of the ship;

(b) the State of registry of the installation;

(c) the State of which the person is a national;

(d) any State where the transmissions can be received; or

(e) any State where authorized radio communication is suffering interference.

4. On the high seas, a State having jurisdiction in accordance with paragraph 3 may, in conformity with article 110, arrest any person or ship engaged in unauthorized broadcasting and seize the broadcasting apparatus.

Article 110
Right of visit

1. Except where acts of interference derive from powers conferred by treaty, a warship which encounters on the high seas a foreign ship, other than a ship entitled to complete immunity in accordance with articles 95 and 96, is not justified in boarding it unless there is reasonable ground for suspecting that:

(a) the ship is engaged in piracy;

(b) the ship is engaged in the slave trade;

(c) the ship is engaged in unauthorized broadcasting and the flag State of the warship has jurisdiction under article 109;

(d) the ship is without nationality; or

(e) through flying a foreign flag or refusing to show its flag, the ship is, in reality, of the same nationality as the warship.

2. In the cases provided for in paragraph 1, the warship may proceed to verify the ship's right to fly its flag. To this end, it may send a boat under the command of an officer to the suspected ship. If suspicion remains after the documents have been checked, it may proceed to a further examination on board the ship, which must be carried out with all possible consideration.

3. If the suspicions prove to be unfounded, and provided that the ship boarded has not committed any act justifying them, it shall be compensated for any loss or damage that may have been sustained.

4. These provisions apply **mutatis mutandis** to military aircraft.

5. These provisions also apply to any other duly authorized ships or aircraft clearly marked and identifiable as being on government service.

Article 111
Right of hot pursuit

1. The hot pursuit of a foreign ship may be undertaken when the competent authorities of the coastal State have good reason to believe that the ship has violated the laws and regulations of that State. Such pursuit must be commenced when the foreign ship or one of its boats is within the internal waters, the archipelagic waters, the territorial sea or the contiguous zone of the pursuing State, and may only be continued outside the territorial sea or the contiguous zone if the pursuit has not been interrupted. It is not necessary that, at the time when the foreign ship within the territorial sea or the contiguous zone receives the order to stop, the ship giving the order should likewise be within the territorial sea or the contiguous zone. If the foreign ship is within a contiguous zone, as defined in article 33, the pursuit may only be undertaken if there has been a violation of the rights for the protection of which the zone was established.

2. The right of hot pursuit shall apply **mutatis mutandis** to violations in the exclusive economic zone or on the continental shelf, including safety zones around continental shelf installations, of the laws and regulations of the coastal State applicable in accordance with this Convention to the exclusive economic zone or the continental shelf, including such safety zones.

3. The right of hot pursuit ceases as soon as the ship pursued enters the territorial sea of its own State or of a third State.

4. Hot pursuit is not deemed to have begun unless the pursuing ship has satisfied itself by such practicable means as may be available that the ship pursued or one of its boats or other craft working as a team and using the ship pursued as a mother ship is within the limits of the territorial sea, or, as the case may be, within the contiguous zone or the exclusive economic zone or above the continental shelf. The pursuit may only be commenced after a visual or auditory signal to stop has been given at a distance which enables it to be seen or heard by the foreign ship.

5. The right of hot pursuit may be exercised only by warships or military aircraft, or other ships or aircraft clearly marked and identifiable as being on government service and authorized to that effect.

6. Where hot pursuit is effected by an aircraft;

(a) the provisions of paragraphs 1 to 4 shall apply **mutatis mutandis**;

(b) the aircraft giving the order to stop must itself actively pursue the ship until a ship or another aircraft of the coastal State, summoned by the aircraft, arrives to take over the pursuit, unless the aircraft is itself able to arrest the ship. It does not suffice to justify an arrest outside the territorial sea that the ship was merely sighted by the aircraft as an offender or suspected offender, if it was not both ordered to stop and pursued by the aircraft itself or other aircraft or ships which continue the pursuit without interruption.

7. The release of a ship arrested within the jurisdiction of a State and escorted to a port of that State for the purposes of an inquiry before the competent authorities may not be claimed solely on the ground that the ship, in the course of its voyage, was escorted across a portion of the exclusive economic zone or the high seas, if the circumstances rendered this necessary.

8. Where a ship has been stopped or arrested outside the territorial sea in circumstances which do not justify the exercise of the right of hot pursuit, it shall be compensated for any loss or damage that may have been thereby sustained.

Article 112
Right to lay submarine cables and pipelines

1. All States are entitled to lay submarine cables and pipelines on the bed of the high seas beyond the continental shelf.

2. Article 79, paragraph 5, applies to such cables and pipelines.

Article 113
Breaking or injury of a submarine cable or pipeline

Every State shall adopt the laws and regulations necessary to provide that the breaking or injury by a ship flying its flag or by a person subject to its jurisdiction of a submarine cable beneath the high seas done wilfully or through culpable negligence, in such a manner as to be liable to interrupt or obstruct telegraphic or telephonic communications, and similarly the breaking or injury of a submarine pipeline or high-voltage power cable, shall be a punishable offence. This provision shall apply also to conduct calculated or likely to result in such breaking or injury. However, it shall not apply to any break or injury caused by persons who acted merely with the legitimate object of saving their lives or their ships, after having taken all necessary precautions to avoid such break or injury.

Article 114
Breaking or injury by owners of a submarine cable or pipeline of another submarine cable or pipeline

Every State shall adopt the laws and regulations necessary to provide that, if persons subject to its jurisdiction who are the owners of a submarine cable or pipeline beneath the high seas, in laying or repairing that cable or pipeline, cause a break in or injury to another cable or pipeline, they shall bear the cost of the repairs.

Article 115
Indemnity for loss incurred in avoiding injury to a submarine cable or pipeline

Every State shall adopt the laws and regulations necessary to ensure that the owners of ships who can prove that they have sacrificed and anchor, a net or any other fishing gear, in order to avoid injuring a submarine cable or pipeline, shall be indemnified by the owner of the cable or pipeline, provided that the owner of the ship has taken all reasonable precautionary measures beforehand.

SECTION 2. CONSERVATION AND MANAGEMENT OF THE LIVING RESOURCES OF THE HIGH SEAS

Article 116
Right to fish on the high seas

All States have the right for their nationals to engage in fishing on the high seas subject to:

(a) their treaty obligations;

(b) the rights and duties as well as the interests of coastal States, provided for, **inter alia**, in article 63, paragraph 2, and articles 64 to 67; and

(c) the provisions of this section.

Article 117
Duty of States to adopt with respect to their nationals measures for the conservation of the living resources of the high seas

All States have the duty to take, or to co-operate with other States in taking, such measures for their respective nationals as may be necessary for the conservation of the living resources of the high seas.

Article 118
Co-operation of States in the conservation and management of living resources

States shall co-operate with each other in the conservation and management of living resources in the areas of the high seas. States whose nationals exploit identical living resources, or different living resources in the same area, shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned. They shall, as appropriate, co-operate to establish sub regional or regional fisheries organizations to this end.

Article 119
Conservation of the living resources of the high seas

1. In determining the allowable catch and establishing other conservation measures for the living resources in the high seas, States shall:

(a) take measures which are designed, on the best scientific evidence available to the States concerned, to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors, including the special requirements of developing States, and taking into account fishing patterns, the interdependence of stocks and any generally recommended international minimum standards, whether sub regional, regional or global;

(b) take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened.

2. Available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis through competent international organizations, whether sub regional, regional or global, where appropriate and with participation by all States concerned.

3. States concerned shall ensure that conservation measures and their implementation do not discriminate in form or in fact against, the fishermen of any State.

Article 120
Marine mammals

Article 65 also applies to the conservation and management of marine mammals in the high seas.

PART VIII

REGIME OF ISLANDS

Article 121
Régime of islands

3. An island is a naturally formed area of land, surrounded by water, which is above water at high tide.

3. Except as provided for in paragraph 3, the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf of an island are determined in accordance with the provisions of this Convention applicable to other land territory.

3. Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf.

PART IX

ENCLOSED OR SEMI-ENCLOSED SEAS

Article 122
Definition

For the purposes of this Convention, "enclosed or semi-enclosed sea" means a gulf, basin or sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States.

Article 123
Co-operation of States bordering enclosed or semi-enclosed seas

States bordering an enclosed or semi-enclosed sea should co-operate with each other in the exercise of their rights and in the performance of their duties under this Convention. To this end they shall endeavour, directly or through an appropriate regional organization:

(a) to co-ordinate the management, conservation, exploration and exploitation of the living resources of the sea;

(b) to co-ordinate the implementation of their rights and duties with respect to the protection and preservation of the marine environment;

(c) to co-ordinate their scientific research policies and undertake where appropriate joint programmes of scientific research in the area;

(d) to invite, as appropriate, other interested States or international organizations to co-operate with them in furtherance of the provisions of this article.

ANNEX II

COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF

Article 1

In accordance with the provisions of article 76, a Commission on the Limits of the Continental Shelf beyond 200 nautical miles shall be established in conformity with the following articles.

Article 2

1. The Commission shall consist of 21 members who shall be experts in the field of geology, geophysics or hydrography, elected by States Parties to this Convention from among their nationals, having due regard to the need to ensure equitable geographical representation, who shall serve in their personal capacities.

2. The initial election shall be held as soon as possible but in any case within 18 months after the date of entry into force of this Convention. At least three months before the date of each election, the Secretary-General of the United Nations shall address a letter to the States Parties, inviting the submission of nominations, after appropriate regional consultations, within three months. The Secretary-General shall prepare a list in alphabetical order of all persons thus nominated and shall submit it to all the States Parties.

3. Elections of the members of the Commission shall be held at a meeting of States Parties convened by the Secretary-General at United Nations Headquarters. At that meeting, for which two thirds of the States Parties shall constitute a quorum, the persons elected to the Commission shall be those nominees who obtain a two-thirds majority of the votes of the representatives of States Parties present and voting. Not less than three members shall be elected from each geographical region.

4. The members of the Commission shall be elected for a term of five years. They shall be eligible for re-election.

5. The State Party which submitted the nomination of a member of the Commission shall defray the expenses of that member while in performance of Commission duties. The coastal State concerned shall defray the expenses incurred in respect of the advice referred to in article 3, paragraph 1(b), of this Annex. The secretariat of the Commission shall be provided by the Secretary-General of the United Nations.

Article 3

1. The functions of the Commission shall be:

   (a) to consider the data and other materials submitted by coastal States concerning the outer limits of the continental shelf in areas where those limits extend beyond 200 nautical miles, and to make recommendations in accordance with article 76 and the Statement of Understanding adopted on 29 August 1980 by the Third United Nations Conference on the Law of the Sea;

(b) To provide scientific and technical advice, if requested by the coastal State concerned during the preparation of the data referred to in subparagraph (a).

2. The Commission may co-operate, to the extent considered necessary and useful, with the Intergovernmental Oceanographic Commission of UNESCO, the International Hydrographic Organization and other competent international organizations with a view to exchanging scientific and technical information which might be of assistance in discharging the Commission's responsibilities.

Article 4

Where a coastal State intends to establish, in accordance with article 76, the outer limits of its continental shelf beyond 200 nautical miles, it shall submit particulars of such limits to the Commission along with supporting scientific and technical data as soon as possible but in any case within 10 years of the entry into force of this Convention for that State. The coastal State shall at the same time give the names of any Commission members who have provided it with scientific and technical advice.

Article 5

Unless the Commission decides otherwise, the Commission shall function by way of sub-commissions composed of seven members, appointed in a balanced manner taking into account the specific elements of each submission by a coastal State. Nationals of the coastal State making the submission who are members of the Commission and any Commission member who has assisted a coastal State by providing scientific and technical advice with respect to the delineation shall not be a member of the sub-commission dealing with that submission but has the right to participate as a member in the proceedings of the Commission concerning the said submission. The coastal State which has made a submission to the Commission may send its representatives to participate in the relevant proceedings without the right to vote.

Article 6

1. The sub-commission shall submit its recommendations to the Commission.

2. Approval by the Commission of the recommendations of the sub-commission shall be by a majority of two thirds of Commission members present and voting.

3. The recommendations of the Commission shall be submitted in writing to the coastal State which made the submission and to the Secretary-General of the United Nations.

Article 7

Coastal States shall establish the outer limits of the continental shelf in conformity with the provisions of article 76, paragraph 8, and in accordance with the appropriate national procedures.

Article 8

In the case of disagreement by the coastal State with the recommendations of the Commission, the coastal State shall, within a reasonable time, make a revised or new submission to the Commission.

Article 9

The actions of the Commission shall not prejudice matters relating to delimitation of boundaries between States with opposite or adjacent coasts.

APPENDIX 3

CITATIONS AND RECOMMENDED READINGS

Adede, A.O. *Toward the Formation of the Role of Delimitation of Sea Boundaries between States with Adjacent or Opposite Coasts.* Virginia Journal of International Law, Vol. 19 No. 2, 1979, 207-55.

American Geophysical Union. *Topex/Poseidon Special Issue.* JGR Oceans, vol 99, no C12, December 15, 1999.

Antunes, N. M. *Towards the Conceptualisation of Maritime Delimitation.* Publications on Ocean Development, Volume 42, Martinus Nijhoff, 2003.

Aust, A. *Modern Treaty Law and Practice.* Cambridge University Press, 2000.

Baeschlin, C.F. *Lerbruch der Geodäsie.* Orell Fuessli Verlag, Zurich.

Baram, M.S., Lee, W., Rice, D. *Maritime Boundaries: A Geographical and Technical Perspective.*

Beazley, P.B. *Maritime Limits and Baselines: a guide to their Delimitation.* London, the Hydrographic Society, 3rd ed 1987.

Beazley, P.B. *Developments in Maritime Delimitation.* Hydrog. Jour. No. 39, Jan. 1986, pp. 5-9.

Beazley, P.B. *Marine mining of the continental shelf: legal, technical and environmental considerations.* Cambridge, Massachusetts, Ballinger, 1978. 301 pp. ISBN 0- 88410-616-0.

Beazley, P.B. *Half-Effect Applied to Equidistance Lines.* Int. Hydrog. Rev. LVI(1) Jan., 1979, pp. 153-160.

Bernaerts, A. *Bernaert's Guide to the 1982 United Nations Convention of the Law of the Sea.* Fairplay Publications Ltd. Coulsdon, Surrey, England, 1988 ISBN 1 870093 151.

Blake, G. *Maritime Boundaries and Ocean Resources.* Durham, 1987.

Bomford, G. *Geodesy, 4th Edition.* Oxford University Press, 1980.

Bouchez, L.J. *The Régime of Bays in International Law.* The Hague, 1964.

Bouchez, L.J. *Law of the Sea Zones in the Pacific Ocean.* Institute of Asian Affairs, Hamburg, Germany, 1987.

Bowett, D.W. *The Legal Regime of Islands in International Law.* New York, 1978.

Brassel, K.E., Reif, D. *A procedure to generate Thiessen polygons.* Geographical Analysis, II(3), 1979.

Brown, E.D. *Delimiting the Continental Shelf Between Opposite and Adjacent States: The North Sea Continental Shelf Cases (Chapter 2).* The Legal Regime of Hydrospace, London : Stevens & Sons, 1971.

Brown, E.D. *Continental Shelf and the EEZ: Problems of Delimitation at UNCLOS III.* Marine Policy and Management, 1977, 377-408.

Brown, E.D. *The Tunisia-Libya continental shelf case, a missed opportunity.* Marine Policy, July 1983, pp. 142-162.

Burmester, H. *Torres Strait: Ocean Boundary Delimitation by Agreement.* AJIL, Vol. 76, 1982, 321-49.

Bursa, M., Kenyon, J., Kouba, J., Sima, Z., Vatrt, V., Vojtiskova, M. *A global vertical reference frame based on four regional vertical datums.* Stud. Geophys. Geod., 48: 493-502, (2004).

Buzan, B. *Seabed politics.* New York, Praeger Publishers, 1976. 311 p. (Praeger Special Studies in International Politics and Government) ISBN 0-275-22850-9.

Carleton, C. M. & Schofield C. H. *Developments in the Technical Determination of Maritime Space: Charts, Datums, Baselines, Maritime Zones and Limits.* International Boundaries Research Unit, University of Durham, Maritime Briefing Vol 3 No 3, 2001.

Carleton, C. M. & Schofield C. H. *Developments in the Technical Determination of Maritime Space: Delimitation, Dispute Resolution, Geographical Information Systems and the Role of the Technical Expert.* International Boundaries Research Unit, University of Durham, Maritime Briefing Vol 3 No 4, 2002.

Caron D. D. & Scheiber H. N., Editors. *Bringing New Law to Ocean Waters.* Publications on Ocean Development Volume 47, Martinus Nijhoff, 2004.

Carrera, G. *A Method for the Delimitation of an Equidistant Boundary Between Coastal States on the Surface of a Geodetic Ellipsoid.* Int. Hydrog. Rev., Vol. LXIV, 1st Ed. Jan. 1987, pp. 147.

Carrera, G. *DELMAR: A Computer Program Library for the DELimitation of International MARitime Boundaries.* International Centre for Ocean Development, Halifax, NS., Canada. 1989.

Charney, J. *Ocean Boundaries Between Nations: A Theory for Progress.* AJIL, Vol. 78, No. 3, 1984, 582-606.

Charney, J. I. & Alexander, L. M., Editors. *International Maritime Boundaries Vols I, II & III.* The American Society of International Law, Martinus Nijhoff, Vols I & II 1993, Vol III, 1998.

Charney, J. I. & Smith, R. W., Editors. *International Maritime Boundaries Vol IV.* The American Society of International Law, Martinus Nijhoff, 2002.

Churchill, R.R. & Lowe, A.V. *The Law of the Sea (2nd Edition).* Manchester University Press, 1989.

Churchill, R.R., Lay, S.H., Nordquist, M. & Simmmonds, K.R. *New Directions in the Law of the Sea.* BIICL, London, 1973.

Clark, D. *Plane and Geodetic Surveying.* Constable & Co., London 1968.

Clarke, R.B. *The waters around the British Isles: their conflicting users.* Oxford, 1987.

Colombos, C.J. *The International Law of the Sea.* David McKay Co. Inc. New York, 6th ed. 1967.

Conforti, B. & Francalanci, G.P. *Atlante dei confini sottomarini.* Guiffre Ed., Milano, 1979-1987.

Cook, P. J. & Carleton, C. M., Editors. *Continental Shelf Limits: The Scientific and Legal Interface.* Oxford University Press, 2000.

Cooper, J. *Delimitation of the Maritime Boundary in the Gulf of Maine Area.* Ocean Development and International Law, Vol. 16, No. 1, 1986.

Court of Arbitration. *The United Kingdom of Great Britain and Northern Ireland and the French Republic: Delimitation of the Continental Shelf.* Geneva, 1977.

Dallmeyer, D.G. & Devorsey, J.L., Editors. *Rights to Ocean Resources.* Martinus Nijhoff, Dordrecht, The Netherlands, 1989.

Danielson, J. *The area under the geodesic.* Survey Review, 30 (232), pp61 – 66, 1989.

Danielson, J. *The use of Bessel-spheres for solution of problems related to geodesics on the ellipsoid.* Survey Review, 32 (253), pp. 445-449, 1994.

Denyer-Green, B. *Libya and Tunisia go to Court over Boundary.* Vol. 4, L & M S, March, 1986, pp. 146-150.

Eustis, F. *Method and Basis of Seaward Delimitation of Continental Shelf Jurisdiction.* Va. J. of Int'l Law, Vol. 17:1, 107-30.

Evensen, J. *The Anglo-Norwegian Case and its Legal Consequences.* 46 AJIL, 1952 pp. 609-630.

Extavour, W.C. *The Exclusive Economic Zone: A Study of the Evolution and Progressive Development of International Law of the Sea.* Institut Universitaire de Hautes Etudes Internationales, Geneva, 1981.

Feldman, M. & Colson, D. *The Maritime Boundaries of the US.* AJIL, Vol. 75, No. 4, 1981, 729-63.

Forbes, V. L. *The Maritime Boundaries of the Indian Ocean Region.* Singapore University Press, 1995.

Forbes, V. L. *Conflict and Co-operation in Managing Maritime Space in Semi-enclosed Seas.* Singapore University Press, 2001.

Francalanci & Scovazzi T., Editors. *Lines in the sea.* Springer, 1994.

Francalanci, G., Romano, D., & Scovazzi T., Editors. *Atlas of Straight Baselines Part 1: Art. 7.* Guiffré Editore, Milano, 1986.

Francalanci, G.P. *Geological Interpretation of Aricle 76 of the UNCLOS.* BHI, SP-56, 1990.

Francalanci, G.P. & Spanio F. *La Convenzione delle Nazioni Unite sul Diritto del Mare.* Istituto Idrografico della Marina, Genova, 1989.

Gardiner, P.R.R. *Reasons and Methods for Fixing the Outer Limit of the Legal Continental Shelf Beyond 200 Nautical Miles.* Revue Iranienne des Relations Internationales 11-12, Spring 1978, pp. 145-177.

Van Gein,W.A., and Gillissen, I. *Area computations of polygons.* International Hydrographic Review, LXX (1), 1993.

Gillissen, I. *Area computations of a polygon on an ellipsoid.* Survey Review, 32 (248): 92-98, 1994.

Glahn Von, G. *Law among Nations.* The Macmillan Co., New York, 1965.

Gold, E. *Maritime transportation: The evolution of International marine policy and shipping law.* Lexington, Massachusetts Lexington Books, 1981.425 pp. ISBN 0-669-04338-9.
Gold, E., Editor. *A New Law of the Sea for the Caribbean.* Springer-Verlag, New York, 1988.

Governments of Iceland and Norway. *Report and Recommendations to the Governments of Iceland and Norway of the Conciliatory Commission on the Continental Shelf area between Iceland and Jan Mayen.* Washington, 1981.

Gray, D.H. *Verifying the Gulf of Maine Computations.* Lighthouse, 32nd Ed., Nov. 1985, Ottawa, Canada.

Groten, E. *Geodesy and the Earth's Gravity Field (Vol.1).* Dummler, Bonn, 1979.

Grundy-Warr, C., Editor. *International Boundaries and Boundary Conflict Resolution.* International Boundaries Research Unit, University of Durham, 1990.

Guy, N.R. *The relevance of non-Legal Technical and Scientific Concepts in the Interpretation and Application of the Law of the Sea.*

Hedberg, H.D. *Ocean Floor Boundaries.* Science Vol. 204, 13, 1979, pp. 135-204.

Heiskanen, W.A. and Moritz, H. *Physical Geodesy.* W.H. Freemann, San Francisco and London, 1967.

Helmert, F.R. *Die matematischen und physikalischen Theorien der höheren Geodäsie.* Teubner, Leipzig. 1880/1884.

Hill, M.N. *The Sea (Vol. 1).* Wiley Interscience. 1962.

Hildreth, R.W.J. *Ocean and Coastal Law.* Englewood Cliffs, N.J., Prentice-Hall, 1983. xxiv, 514 p., ISBN 0-13-629204-6.

Hirtle, R.W.M. *Preliminary Condensed Report on the Determination of Base of Slope Using Hydrographic Data and Computer-assisted Graphic Analysis.* Unpublished.

Hodgson, R.D. *Maritime Limits and Boundaries.* Marine Geodesy, V.1, No. 2, 155-63.

Hodgson, R.D. *Islands: Normal and Special Circumstances.* INR Research Study No. 3.

Hodgson, R.D. & Alexander L.M. *Towards an Objective Analysis of Special Circumstances Rivers, Coastal and Oceanic Archipelagos and Atolls.* Law of the Sea Institute, University of Rhode Island, Occasional Paper No. 13, 1972, pp. 45-52.

Hodgson, R.D. & Cooper, J.E. *The Technical Delimitation of a Modern Equidistant Boundary.* Ocean Development and International Law Jour. Vol. 3, No. 4, 1976, 361-388.

Hodgson, R.D. & Smith, R.W. *The Informal Single Negotiating Text (Committee II): A Geographical Perspective.* Ocean Dev. and Int. Law Jour. Vol. 3, No. 3, 1976, 225-259.

Hodgson, R.D. & Smith, R.W. *Boundary Issues Created by Extended National Marine Jurisdiction.* The Geographical Review, Vol. 69, 1979, 423-33.

Hofmann-Wellenhof, B., Lichtenegger, H., and Collins J. *GPS, Theory and Practice.* Springer-Verlag. 5th edition 2001.

Hollick, A.L. *U.S. Foreign Policy and the Law of the Sea.* Princeton, Princeton University Press. Lexington, Mass., Lexington Books, 1983. 207 pp. ISBN 0-669-06146-8.

Hunt, L.M. & Groves, D.G., Editors. *A Glossary of Ocean Science and Undersea Technology Terms.* Compass Publications, Inc., Arlington, VA.

Hyde, C.C. *International Rivers.* US Department of State, House Inquiry Handbook, No. 16, Washington, Government Printing Office, 1918.

Hydrographer of the Navy. *The Mariners' Handbook.* Taunton, 1979.

International Association of Geodesy. *The Geodesist's Handbook.* Bulletin Géodésique 54 (3).

International Court of Justice. *Case concerning the Continental Shelf (Malta/Libyan Arab Jamahiriya).* The Hague, 1984.

International Court of Justice. *Definition of the Maritime Boundary in the Gulf of Maine Area (Canada/U.S.A.).* Judgment, The Hague, 1985.

International Court of Justice. *The North Sea Continental Shelf Case, Reports of Judgements Advisory Opinion and Orders.* The Hague, 1969.

International Court of Justice. *Continental Shelf – Tunisia/Libyan Arab Jamahiriya.* Judgement, The Hague, 1982.

International Court of Justice. *Land and Maritime Boundary between Cameroon and Nigeria: Equatorial Guinea intervening.* Judgement, The Hague, 2002.

International Court of Justice. *Maritime Delimitation and Territorial Questions between Qatar and Bahrain.* Judgement, The Hague, 2001.

International Court of Justice. *Maritime Delimitation between Guinea-Bissau and Senegal.* Judgement, The Hague, 1995.

International Court of Justice. *Maritime Delimitation in the Area between Greenland and Jan Mayen.* Judgement, The Hague, 1993.

International Court of Justice. *Continental Shelf (Tunisia/Libyan Arab Jamahiriya).* Judgement, The Hague, 1982.

International Court of Justice. *Aegean Sea Continental Shelf (Greece/Turkey).* Judgement, The Hague, 1978.

International Court of Justice. *Fisheries (United Kingdom/Norway).* Judgment, The Hague, 1950.

International Court of Justice. *Land, Island and Maritime Frontier Dispute (El Salvador/Honduras: Nicaragua intervening.* The Judgement 1992.

International Hydrographic Organization. *Chart Specifications of the IHO.* MP-004, Monaco.

International Hydrographic Organization. *Hydrographic Dictionary.* Special Public. No. 32 Monaco.

International Hydrographic Organization & Intergovernmental Oceanographic Commission. *Standardization of Undersea Feature Names.* IHO/IOC BP-006, Monaco, 1989.

Jagota, S.P. *Maritime Boundary.* Martinus Nijhoff, Dordrecht, The Netherlands, 1985.

Johnston, D. M. *The Theory and History of Ocean Boundary Making.* McGill-Queen's University Press, 1988.

Jones, S.B. *Boundary-Making, A Handbook for Statesmen, Treaty-Editors and Boundary Commissioners.* Carnegie Endowment for International Peace.Washington, D.C., 1945.

Junkins, D.R. *The National Transformation. In Moving to NAD '83, D.C. Barnes, Editor.* CISM, Ottawa, pp. 16-40,1991.

Kapoor, D.C. *The Delimitation of Exclusive Economic Zones.* Marine Policy and Management, Vol. 4, 1976.

Kennedy, R.H. *Brief Remarks on Median Lines and Lines of Equidistance and on the Methods used in their Construction.* Provided to the U.K. delegation of the Law of the Sea Conference, April 2, 1958.

Kerr, A.J. & Kapoor, D.C. *A Guide to Maritime Boundary Delimitation.* Carswell, Toronto, Canada, 1986.

Kerr, A.J. & Keen, M.J. *Hydrographic and Geologic Concerns of Implementing Article 76.* Int. Hydrog. Rev. LXII (I), 1985, pp. 139-148.

Kimerling, J. *Area computation from geodetic coordinates on the spheroid.* Surveying and Mapping, 44(4): 343-351 1984.

Kyosti, H. *Questions juridiques surgies lors de la révision de la frontière finlandaise entre le golfe de Bothnie et l'océan Glacial.* Fennia, Vol. 49, 1929, 1-46.

Langeraar, W. *Maritime Delimitation. The Equiratio Method - A New Approach.* Marine Policy, Jan. 1986.

Lambeck, K. *Geophysical Geodesy.* Clarendon Press, Oxford, 1988.

Leick, A. *GPS satellite surveying.* Wiley Interscience. 2nd Edition 2004.

Macnab, R. Mukherjee, P.K. Buxton, R. *The 1982 U.N. Convention on the Law of the Sea and the Outer Limit of the Continental Shelf: Some Practical Difficulties for Wide-Margin States.* OCEANS 87 Conference Proceedings, Halifax, Canada, Oct. 1987.

Mailing, D.H. *Coordinate Systems and Map Projections.* Pergamon Press.2nd Edition 1992.

Mikhail, E.M. *Observations and Least Squares.* IEP - Dun-Donnelley, New York. 1976.

Miyoshi, M. *The Joint Development of Offshore Oil and Gas in Relation to Maritime Boundary Delimitation.* International Boundaries Research Unit, University of Durham, Maritime Briefing Vol 2 No 5, 1999.

Moritz. H. *Geodetic Reference System 1980.* The Geodesist's Handbook, Journal of Geodesy 74: 128- 133.

Nahavandchi, H., and Sjöberg, L.E. *Unification of vertical datums by GPS and gravimetric geoid models using modified Stokes's formula.* Marine Geodesy, 21(4): 261-273. 1998.

National Imagery and Mapping Agency. *Department of Defence World Geodetic System 1984: Its definition and Relationships with Local Geodetic Systems.* NIMATechnical Report 8350.2, 3rd Edition Washington DC. 1997.

Nichols, S. *The Gulf of Maine Boundary: Reviewing the Issues.* Occasional Paper No. 12, University of New Brunswick, Dept. of Surveying Engineering, Fredericton, N.B., Canada, 1982.

Nihon Suiro Kyokai (Japan Hydrographic Association). *Suiro Sokuryo Jokan (Hydrographic Survey, Part I).* Tokyo, Nihon Suiro Kyokai, 1980. 324 pp.

Nordquist, M. H. Series Editor in Chief. *United Nations Convention on the Law of the Sea 1982: A Commentary Vols I – VI.* Center of Oceans Law and Policy, University of Virginia School of Law, Martinus Nijhoff, 1985 – 2002.

Nordquist, M. H., Norton Moore, J. & Heidar, T. H., Editors. *Legal and Scientific Aspects of Continental Shelf Limits.* Martinus Nijhoff, 2004.

O'Connell, D.P. *The International Law of the Sea, Vols I & II.* Clarendon Press, Oxford, 1982.

Oda, S. *The Law of the Sea in Our Time.* The U.N. Seabed Committee 1968-1973, Vol. 1, New Development, 1977.

Oude Elferink A. G. and Rothwell D. R., Editors. *Oceans Management in the 21st Century: Institutional Frameworks and Responses.* Publications on Ocean Development, Volume 44, Koninklijke Brill NV., 2004.

Pan, M. and Sjöberg, L.E. *Baltic Sea Level project with GPS.* Bulletin Géodésique, 67, pp. 51-59. 1993.

Pearson, F. *Map Projections. Theory and applications.* CRC Press, Boca Raton, Fla., USA.1990.

Prescott, J.R.V. *An Analysis of the Geographic Terms in the United Nations Convention on the Law of the Sea.* Unpublished document of the Government of Australia.

Prescott, J.R.V. And Schofield C.H. *The Maritime Political Boundaries of the World.* Martinus Nijhoff, 2005.

Prescott, J.R.V. *The Political Geography of the Oceans.* David & Charles Ltd., Newton Abbott, 1975.

Prescott, J.R.V. *Political Frontiers and Boundaries.* Melbourne, 1987.

Prescott, J.R.V. *Delimitation of Marine Boundaries by Baselines.* Marine Policy Reports Vol. 8, No. 3, University of Delaware, Jan. 1986.

Reed, M. W. *Shore and Sea Boundaries, Volume 3.* US Government Printing Office, 2000.

Renouf, J.K. *Canada's Unresolved Maritime Boundaries.* University of New Brunswick, Dept. of Surveying Engineering, Technical Report No. 134, Fredericton, N.B., Canada, Jan. 1988.

Rhee, Sang-Myon. *Equitable Solution to the Maritime Boundary Dispute... Gulf of Maine.* AJIL, Vol. 75, 1981 590-628.

Rice, C.M *Dictionary of Geologic Terms.* Edward Bros., Inc., Ann Harbor, Michigan, 1957.

Richardus, P. *Project surveying.* A. A. Balkema, Rotterdam and Boston.1984.

Rizos, C., Editor. *Contributions to GPS studies.* UNISURV, S-38, pp. 45-101.1990.

Roach, J. A. & Smith, R. W. *United States Responses to Excessive Maritime Claims.* Publications on Ocean Development, Volume 27, Martinus Nijhoff, 1996.

Ruffman, A.,Gault, I.T. & Vanderzwaag, D. *Legal jurisdiction over the Titanic.* Lighthouse Edition 37, 1988.

Sato, T. & Oshima, S. *Continental Shelf Survey Project of Japan.* International Hydrographic Review LXV(1), Jan. 1988.

Schofield, C.H. & Carleton, C.M. *Technical Considerations in Law of the Sea Dispute Resolution.* Ch. 12 in Oude Elferink A. G. and Rothwell D. R. (eds), 2004.

Schofield, C.H., Newman, D., Drysdale, A. & Brown, J. A., Editors. *The Razor's Edge:* Kluwer Law International, 2002.*International Boundaries and Political Geography.*

Seeber, G. *Satellite Geodesy.* W. de Gruyter, Berlin, New York. 1st edition 1993; 2nd edition 2003.

Sideris, M. *Regional geoid determination. In P. Vanicek and N.T. Christou (Eds.): Geoid and its geophysical interpretations.* CRC Press, Boca Raton, Fla, Ch. 4.1994.

Shalowitz, A.L. *Shore and Sea Boundaries, Vols 1 & 2.* U.S. Dept. of Commerce Publication 10-1, U.S. Govt. Printing Office, 1962.

Sjöberg, L.E. *Techniques for geoid determination. In P. Vanicek and N. T. Christou (Eds.): Geoid and its geophysical interpretations.* CRC Press, Boca Raton, Fla, Ch. 2. 1994.

Sjöberg. L.E. *An efficient iterative solution to transform rectangular to geodetic coordinates.* ZfV 126(9): 295-297.1999.

Sjöberg, L.E. *Determination of areas on the plane, sphere and ellipsoid.* Submitted to Survey Review.

Sjöberg, L.E. *New solutions to the direct and indirect geodetic problems on the ellipsoid.* Zeitschrift fuer Vermessungswesen, 131: 35-39, 2006.

Smith R. W. & Colson D., Editors. *International Maritime Boundaries, Vol V.* The American Society of International Law, Martinus Nijhoff, 2005.

Smith R. W. & Thomas B. L. *Island Disputes and the Law of the Sea: An Examination of Sovereignty and Delimitation Disputes.* International Boundaries Research Unit, University of Durham, Maritime Briefing Vol. 2 No. 4, 1998.

Smith, R.W. *Exclusive Economic Zone Claims.* Dordrecht, 1986.

Stamp, D. & Clark, A.P. *A Glossary of Geographical Terms.* 3rd ed. Longman Group Ltd. London, 1979.

Stommel, H. *Varieties of oceanographic experience.* Science 139, pp. 572-576.1963.

Strohl, M.P. *The International Laws of Bays.* Martinus Nijhoff, The Hague, 1983.

Symmons, C. *Some Problems Relating to the Definition of Insular Formations in International Law: Islands and Low-Tide Elevations.* International Boundaries Research Unit, University of Durham, Maritime Briefing Vol. 1 No. 5, 1995.

Symmons, C.R. *The Maritime Zones of Islands in International Law.* Martinus Nijhoff, The Hague, 1979.

Thamsborg, M. *Geodetic Hydrography as Related to Maritime Boundary Problems.* Int. Hydrog. Rev. Vol. 51, No. 1, p. 157-173, 1974.

Thamsborg, M. *Notes on Hydrographic Assistance to the Solution of Sea Boundary Problems.* Int. Hydrog. Rev., p. 149-159, 1971.

Thamsborg, M. *On the Precise Determination of Maritime Boundaries.* Unpublished manuscript; Hydrographic Office Esplanaden 19, 1263 Copenhagen, Denmark, 1983.

Torge, W. *Geodesy.* W. de Gruyter, Berlin, New York.3rd edition 2001.

United Nations. *Law of the Sea Bulletin Nos 1 – 54.* Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, 1982 - 2004.

United Nations. *Handbook on the Delimitation of Maritime Boundaries.* Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, 2000.

United Nations. *Juridical Regime of Historic Waters.* ILC Yearbook 1962, Vol. 2, pp. 1-66.

United Nations. *National Legislation and Treaties Relating to the Law of the Sea.* Legislative Series, New York, 1970.

United Nations. *United Nations Convention on the Law of the Sea.* New York, 1983.

United Nations. *Maritime Boundary Agreements (1970-1984).* Office of Ocean Affairs and the Law of the Sea, NY, 1987, No. E.87.V.12 ISBN 92-1-133302-4.

United Nations. *Baseline: An examination of the Relevant Provisions of the United Nations Convention of The Law of the Sea.* New York, 1989 UN Publication E.88.V.5 ISBN 92-1-133308-2.

United Nations. *Annual Review of Ocean Affairs Law and Policy, Main Documents 1985-1987, Vols. I & II.* UNIFO Publishers Inc. Sarasota, Florida, 1989.

United Nations. *Scientific and Technical Guidelines.* Commission on the Limits of the Contoinental Shelf. http://www.un.org/Depts/los/clcs_new/commission_documents.htm

United Nations. *Law of the Sea: List of Terms Relating to the Law of the Sea in Arabic, English, French, Russian and Spanish.* New York, 1976.

United States Board on Geographic Names. *Gazetteer of Undersea Features.* 4th ed., Defense Mapping Agency, Washington, D.C., 1990.

United States Defense Mapping Agency. *Department of Defense World Geodetic System 1984 - Its Definition and Relationships with Local geodetic Coordinate Systems.* Department of Defense, World Geodetic System 1984, DMA TR 8350.2, 30 Sept. 1987.

United States Department of Defense. *Maritime Claims, Reference Manual.* DOD 2005 1-M. 2 volumes Washington, 2nd ed., 1990.

United States Department of State. *Limits in the Seas.* Series, Washington, 1969.

University of Hawaii. *Proceedings of the Law of the Sea Institute.* University of Hawaii Annual Conferences

Vaníček, P. *Vertical datum and NAVD 88.* Surveying and Land Information Systems, 51 (2), pp. 83-86.1991.

Vaníček, P. *The problem of a maritime boundary involving two horizontal geodetic datums.* Proceedings of the First International Conference on Geodetic Aspects of the Law of the Sea, Bali, Indonesia, June 8-11, 1992.

Vaníček, P. *On the global vertical datum and its role in maritime boundary demarcation.* Proceedings of INSMAP 94 conference. Hannover, Germany, September 19-23, 1994.

Vanicek, P. & Krakiwsky, E. *Geodesy, the concepts.* North-Holland, Amsterdam, NY, Oxford, Tokyo, 2nd Ed. 1986.

Vaníček, P. And Lugoe F.N. *Rigorous Densification of Horizontal Networks.* Journal of Surveying Engineering, Vol. 1120), pp. 18-29,1986.

Vaníček, P. And N. Christou, Editors. *Geoid and Its Geophysical Interpretations.* CRC Press, Boca Raton, Fla., USA, 1994.

Vaníček, P., Wells, D.E., Hou, T. And Ou, Z. *First experiences with continental slope foot line determination from real bathymetric data.* Proceedings of INSMAP 94 conference. Hannover, Germany, September 19-23, 1994.

Vermeille, H. *Direct transformation from geocentric coordinates to geodetic coordinates.* J. Geod. 76: 451-454, 2002.

Vincenty, T. *Direct and inverse solutions on the ellipsoid with application of nested equations.* Survey Review, XXII (176), pp. 88-93. 1975.

Walcott, R.I. *Late quaternary vertical movements in eastern North America: Quantitative evidence of glacio-isostatic rebound.* Rev. Geophys.and Space Phys., 10(4), pp. 849-884, 1972.

Warren, B.A. And Wunsch, C. Editors *Evolution of Physical 0ceanography.* MIT Press, Cambridge, Mass. and London, 1981.

Weil, P. *The Law of Maritime Delimitation – Reflections.* Grotius Publications Ltd. Cambridge, 1989.

Wells, D., Back, N., Delikaraoglou, D., Kleusberg, A., Krakiwsky, E.J., Lachapelle, G., Langley, R.B. , Nakiboglu, M., Schwarz, K-P., Tranquilla J.M. And Vaníček P. *Guide to GPS Positioning (2nd printing).* Canadian GPS Associates, Fredericton, NB, Canada. 1987.

Westerman, G.S. *The Juridical Bay.* Oxford, 1987.

Wright, E.S. *The Application of an Area-weighted Equidistance Principle to the Problem of Maritime Boundary Delimitation.* Unpublished manuscript.

APPENDIX 4

MEMBERSHIP OF TALOS WORKING GROUP

The following is a cumulative list of individuals who have been the members of the TALOS Group between 1985-1993 and contributed to the preparation of the TALOS Manual either by correspondence or by personally attending the meetings of the Group: -

Rear Admiral A.A. YUNG ....Argentina
Lt. Cdr. E. RODRIGUEZ ....Argentina
Cdr. M.A. BOMPET...Brazil
Capt. P.K. MUKERJEE...Canada
LT. Cdr. H. GORZIGLIA..Chile
Cdr. M. THAMSBORG...Denmark
Ing. en Chef CAILLIAU..France (1985/1989)
Ing. en Chef HABERT..France (1988/1989)
Ing. General A. ROUBERTOU ....France (1990)
Rear Admiral G. PAPATHEOFANOUS...............................Greece (1985-1989)
Captain I. PAPPAS ....Greece (1990)
Cdr. D. SENGUPTA..India (1985-1989)
Commodore P.P. NANDI ....India (1990)
Rear Admiral A. CIVETTA...Italy (1985-1987)
Captain F. SPANIO ....Italy (1988-1990)
Dr. Gian Petro FRANCALANCI...Italy (1985-1990)
Dr. Shoichi OSHIMA ....Japan (1985-1989)
Mr. Shigeru KATO ....Japan (1989-1990)
Mr. Mario C. MANASALA ....Philippines (1985-1987)
Mr. W.R. JIMENEZ...Philippines (1987-1990)
Commodore N.R. GUY ....Republic of South Africa
Cdr. R.L.C. HALLIDAY ....U.K. (1985-1987)
Lt. Cdr. C.M. CARLETON ....U.K. (1987-1990)
Dr. R.W. SMITH ....U.S.A.
Captain S.V. VALTCHOUK ....U.S.S.R.
Late Rear Admiral F.L. FRASER (Chairman) ......................I.H.B. (1985-1987)
Mr. A.J. KERR (Chairman)...I.H.B. (1987-1990)
Cdr. N.N. SATHAYE (Secretary) ....I.H.B. (1985-1986)
Lt. Cdr. E.H. TORRES (Secretary)..I.H.B. (1987-1988)
Lt. Cdr. F. BERMEJO-BARO (Secretary) ............................I.H.B. (1988-1989)
Captain I.A. ABBASI (Secretary) ....I.H.B. (1989-1990)
Captain H.P. ROHDE (Secretary) ....I.H.B. (1992-1993)

In addition to the above, the Directing Committee of the International Hydrographic Bureau also gratefully acknowledges the contribution made by Lt. Cdr. BEAZLEY of the United Kingdom in his capacity as the Bureau's consultant; and by the following members of the Special Study Group (SSG) of the International Association of Geodesy (IAG): -

Dr. Petr VANICEK ....Canada
Mr. Galo CARRERA ....Canada
Mr. Jack WEIGHTMAN ....U.K.

The Editorial Group formed in 2003 to prepare the 4th Edition comprised the following members of ABLOS:

Ron MACNAB – Chairman..(Canada)
Steve SHIPMAN ....(IHB)
Lars SJOBERG ....(Sweden)
Carlo DARDENGO ....(Italy)
Chris CARLETON..(UK)
Shin TANI..(Japan)

Illustrations for the 4th Edition were prepared under the direction of Mr Shigeru Kasuga of the Japanese Hydrographic and Oceanographic Department. Dr. Masayuki Fujita redesigned the geodetic figures. Graphic work was undertaken by Dr. Tomoyuki Sasaki of the University of Tokyo, under the supervision of Prof. Kensaku Tamaki of the University of Tokyo. Mr Yoshihiro Matsumotu assisted with communication and with final adjustment of all figures. Mr Shin Tani made the initial arrangements. It is acknowledged that this work was made possible with financial support from the Nippon Foundation and from the Ocean Policy Research Foundation of Japan.